ENGINEERING

An Illustrated Weekly Journal

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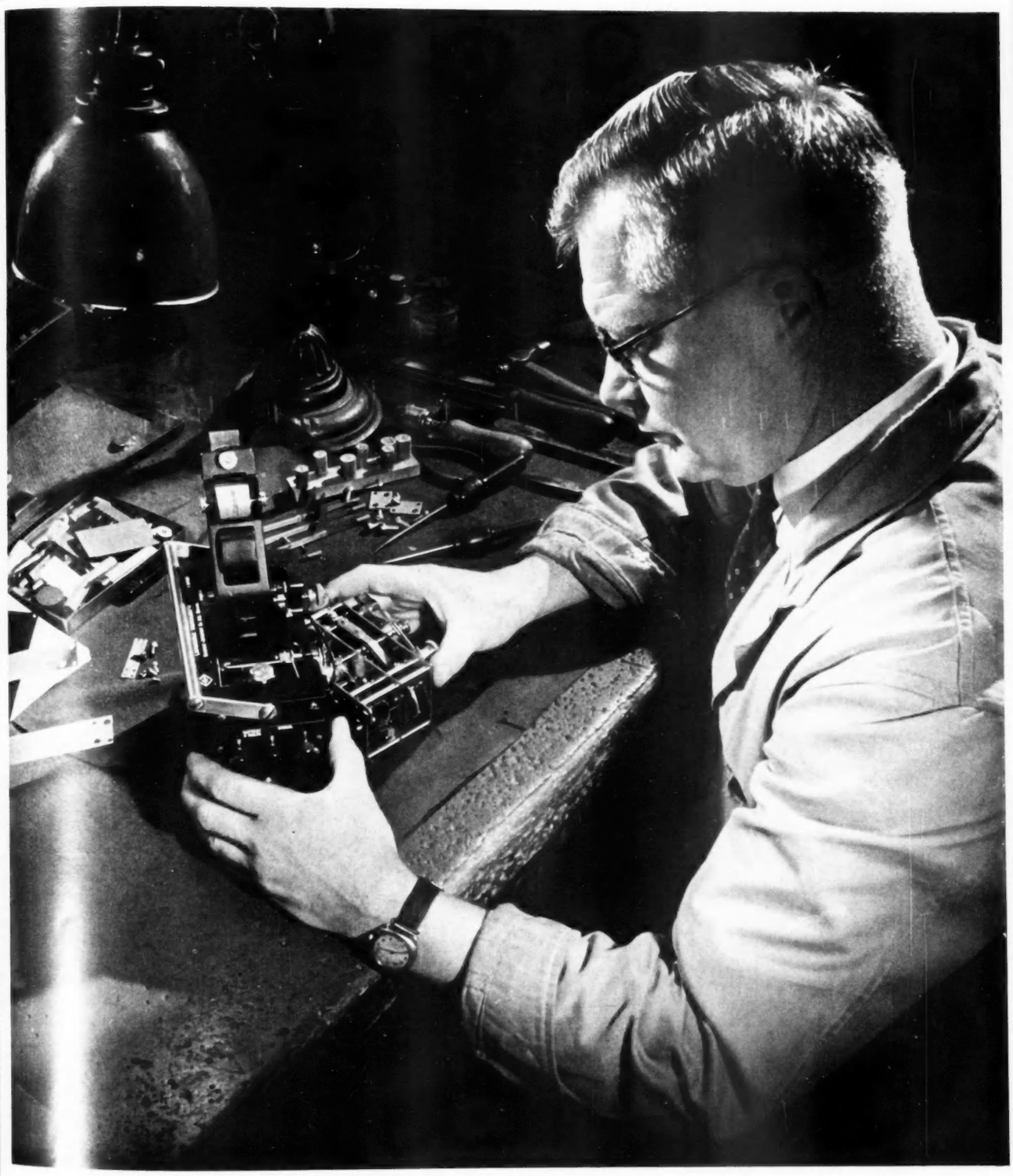

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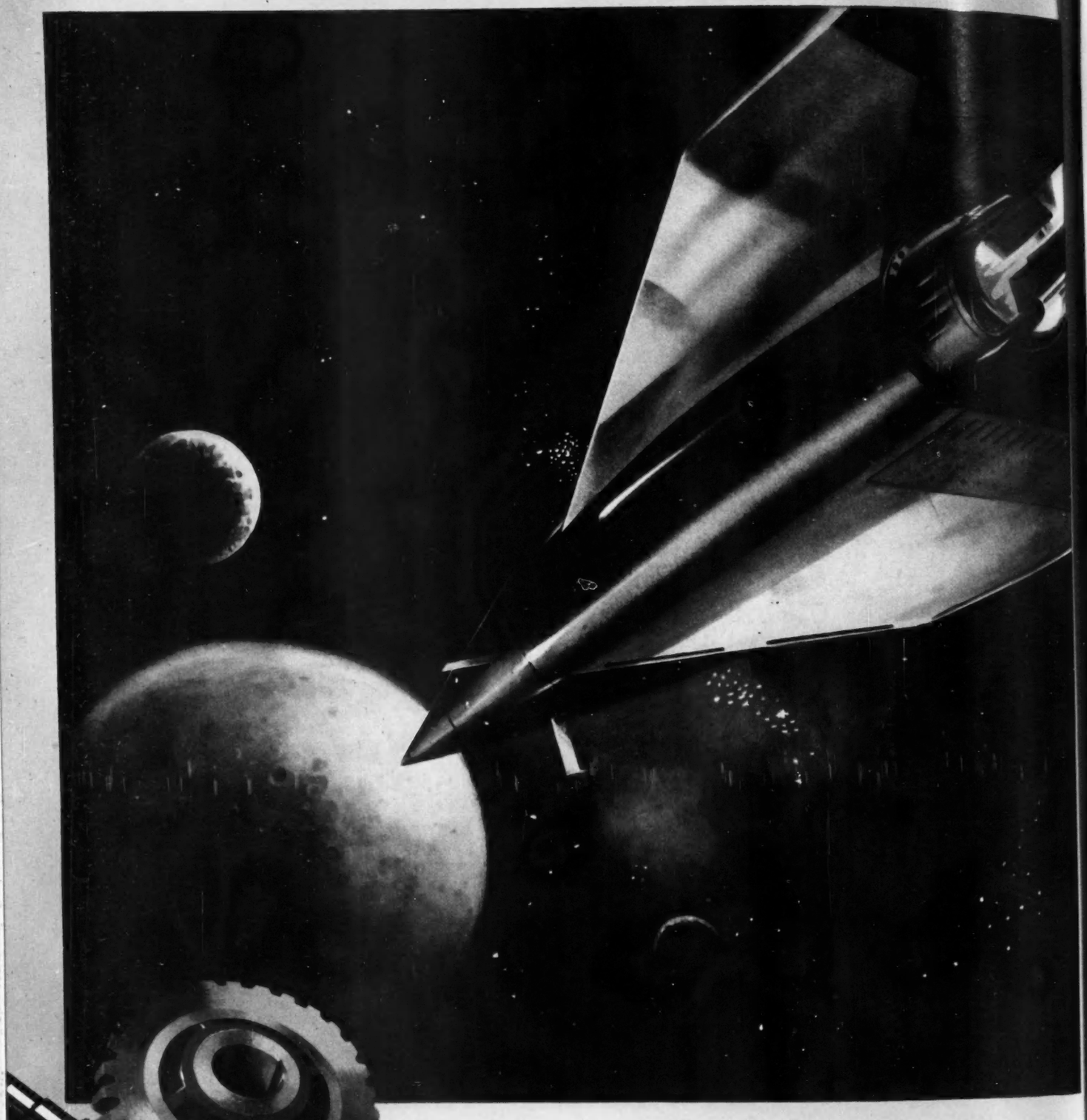

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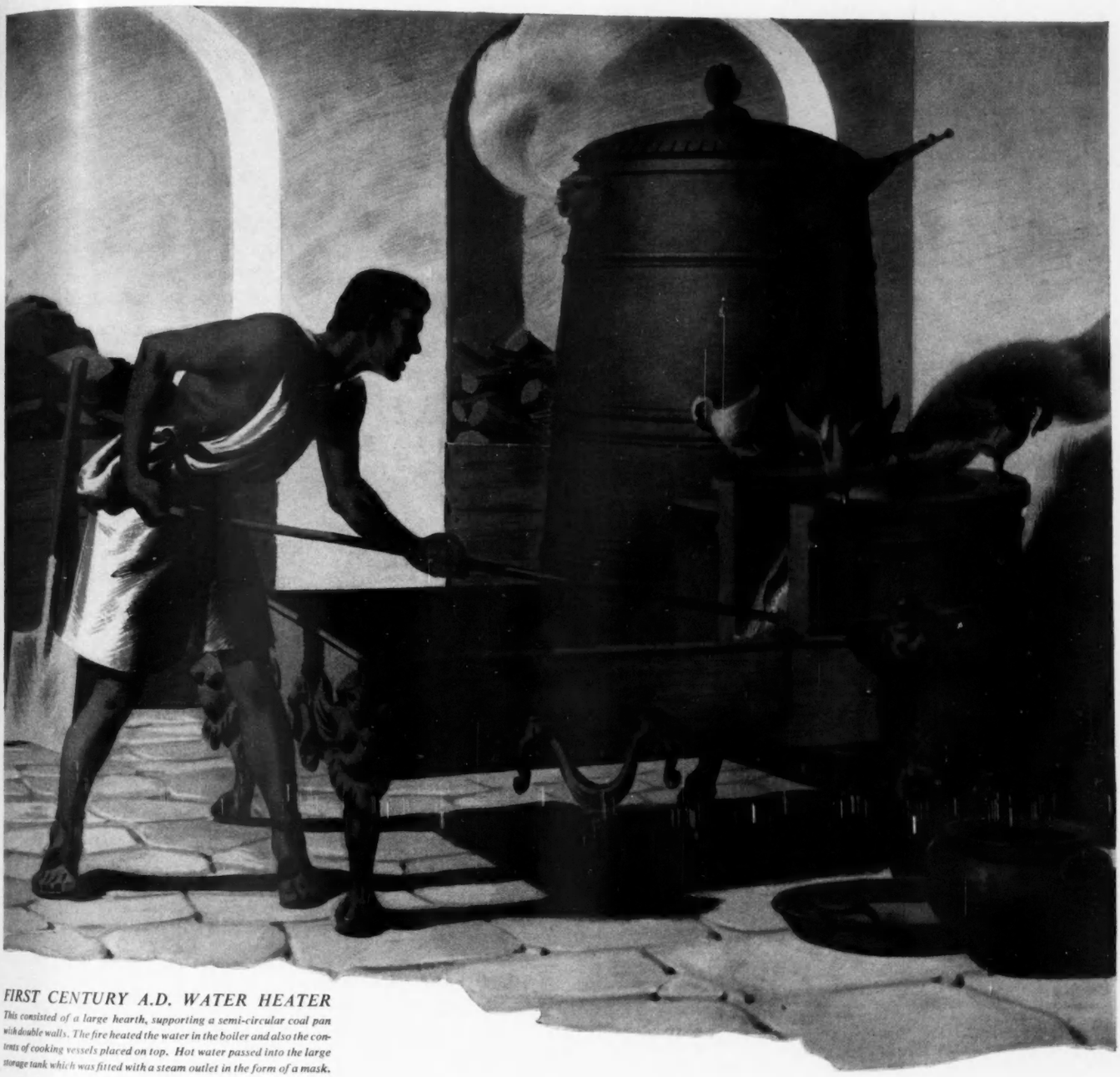

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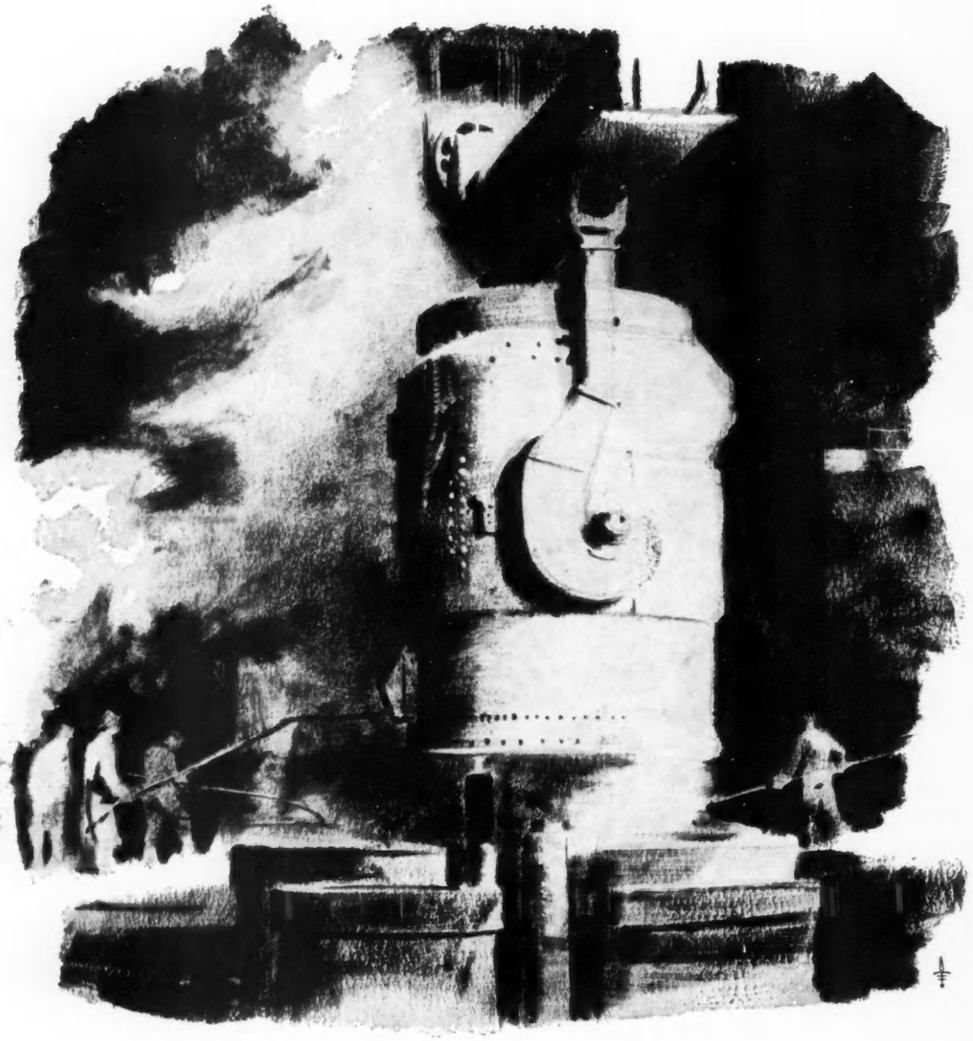

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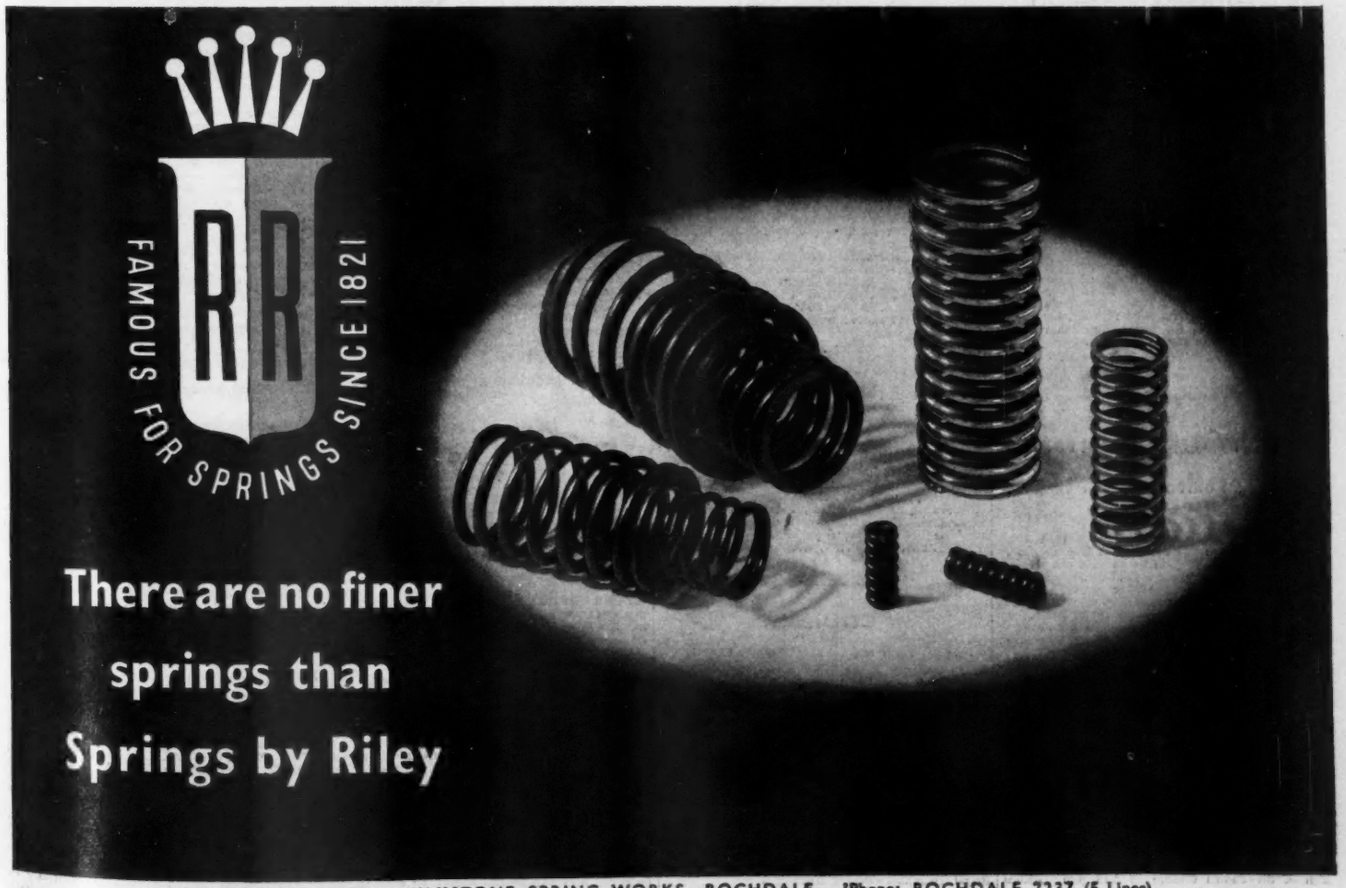

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CLASSIFIED ADVERTISEMENTS SECTION.

For all advertisements classified under the headings of Tenders, Appointments Open, Situations Wanted, Patent Agents, Partnerships, Wanted, &c., Auction Sales, Publications For Sale, Miscellaneous and Public Notices, &c., the charge will be 12s. for the first four lines or under and 3s. per line up to one inch. When an advertisement measures an inch or more, the charge will be at the rate of 36s. per inch. 5% allowed on 6, 10% on 13, 15% on 26 and 20% on 52 Weekly insertions. If use is made of a box number the extra charge is 2s. per insertion with the exception of advertisements appearing under Situations Wanted. Prospectuses and Notices of Company Meetings £25 per column. Copy instructions must be in our hands first post Monday for the following Friday's issue. Address to the Manager, ENGINEERING LTD., 35 and 36, Bedford St., Strand, W.C.2. Inclusion of advertisements must be dependent on space being available.

PUBLIC NOTICES.

ROYAL CORPS OF NAVAL CONSTRUCTORS

SCHOOLS ENTRY.

A COMPETITION for a new form of entry into the Royal Corps of Naval Constructors will be held in July, 1956.

Accepted candidates will be established as Probationers in the R.C.N.C. and will undergo a 2-year course of training at the R.N. Engineering College, Manadon, and in H.M. Dockyard, Devonport, followed by a 3-year course at the R.N. College, Greenwich.

Candidates must be aged between 18 years and 19 years 6 months inclusive on 1st September, 1956.

Candidates with the General Certificate of Education will be required to have passed at Advanced Level in at least Pure Mathematics, Applied Mathematics and Physics, and to produce evidence of general education at Ordinary level.

Candidates with the Scottish Leaving Certificate will be required to have higher grade passes in Physics and Mathematics and at least lower grade passes in English and a language other than English and two other subjects (preferably mathematical).

Candidates from schools in Northern Ireland will be required to produce a certificate from the Ministry of Education in Northern Ireland showing a comparable standard to that above.

The work of the R.C.N.C. covers all aspects of design construction and repair of H.M. Ships. Members undertake to serve wherever required at Admiralty Headquarters and outports in the United Kingdom, and at Royal Dockyards at Home and Abroad. The Head of the R.C.N.C. is the Principal Technical Adviser to the Board of Admiralty.

Total pay for probationers will commence at £313 10s. 0d. p.a. at the R.N.E.C. at age 18, rising to £575 at Greenwich at age 23. The successful probationer can expect appointment as Assistant Constructor usually at age 23 with total pay (London) of £805. Promotion to constructor is at about age 30 with total pay of £1399 rising in 9 years to £1750. Promotion to higher ranks with top salary £3500 is by selection.

Full particulars may be obtained from the SECRETARY OF THE ADMIRALTY, C.E. BRANCH II, EMPIRE HOTEL, BATH, to whom final applications must be submitted by 15th June, 1956. K 999

EDUCATIONAL.

FREE. Brochure giving details of courses in Mechanical and Production Engineering, Draughtsmanship, etc., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional examinations. E.M.I. INSTITUTES, DEPT. EG. 30, LONDON, W.4. (ASSOCIATED WITH H.M.V.). G 619

THE INSTITUTION OF CHEMICAL ENGINEERS.

32ND (1956) EXAMINATION.

Application forms for entrance to the 1956 Examination, returnable not later than the 1st June, 1956, may be obtained from the GENERAL SECRETARY, THE INSTITUTION OF CHEMICAL ENGINEERS, 56, VICTORIA STREET, LONDON, S.W.1. In applying for forms, applicants should state which parts of the examination they propose to take. L 146

ANNOUNCEMENTS.

CAMBRIDGE UNIVERSITY ENGINEERS ASSOCIATION.

This Association, which was founded in 1929, aims at keeping former students of the University Engineering Department in touch with one another and also in touch with the considerable amount of research in progress and the other current activities of the Cambridge Engineering School. The present membership of the Association is approximately 2,000 and a new Register of Members is now being printed. The customary Bulletin of the Association is due for publication in May.

The present Executive Committee is anxious to increase the membership of the Association by trying to make touch with the many Cambridge Graduates with whom contact has been lost. Life Membership can now be secured by a single payment of two guineas and full particulars of the Association, with form of application for membership, can be obtained from the Hon. Secretary, C.U.E.A., Engineering Laboratory, Trumpington Street, Cambridge.

The Executive Committee give this advance notice of the next Summer Reunion to be held in Cambridge on Saturday, 14th July, 1956. There will be an "At Home" in the Engineering Laboratories during the afternoon, the Annual General Meeting of the Association will be held at 5 p.m., and the Association's Dinner will take place in the Hall of St. John's College at 8.15 p.m. Ladies accompanying members will be welcome at the "At Home" and at the Dinner. L 99

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FELLOWSHIPS.

BRITISH OXYGEN COMPANY FELLOWSHIPS.

Applications are invited for **THREE POST-GRADUATE FELLOWSHIPS** of annual value between £350 and £600 per annum. These Fellowships are tenable at Universities and Technical Colleges in the U.K. for two years with the possibility of renewal for a third year. Assistance may also be given for equipment connected with the research which is undertaken.

(1) Two Fellowships will be awarded for research on subjects broadly related to air separation. Such subjects include not only separation of air by low temperature or other methods, but also allied topics such as purification, compression, or heat exchange at low temperatures.

(2) The third Fellowship will be awarded for research connected with the use of protective gases in metallurgical operations, including welding.

Further particulars and application form may be obtained from the SECRETARY, BRITISH OXYGEN FELLOWSHIPS COMMITTEE, BRIDGEWATER HOUSE, CLEVELAND ROW, ST. JAMES'S, LONDON, S.W.1.

Applications should be received before the 12th June, 1956. L 132

UNIVERSITY OF NOTTINGHAM.

DEPARTMENT OF MECHANICAL ENGINEERING.

Applications are invited for the **BRITISH RUBBER PRODUCERS' RESEARCH FELLOWSHIP**, value up to £500 per annum. The Fellowship has been instituted to encourage research into the mechanical properties of rubber. Applicants should have a good Honours degree in Engineering or Physics, and industrial or research experience. Full particulars and application form may be obtained from the REGISTRAR, UNIVERSITY OF NOTTINGHAM. L 155

COURSES.

ROYAL TECHNICAL COLLEGE, SALFORD.

DEPARTMENT OF MECHANICAL ENGINEERING.

ACTING HEAD OF DEPARTMENT: W. F. FISH, M.A., Wh.Sc., A.M.I.Mech.E.

POST-GRADUATE COURSES ON "SYNTHESIS OF MECHANISMS."

A post-graduate course of four lectures will be given by Dr. Ing. Paul Grodzinski, A.M.I.Mech.E., on Friday and Saturday, 21st and 22nd September, 1956.

The fee for the lectures will be 2 guineas. Further details and forms of application may be obtained from the Organising Lecturer:—R. C. Brewer, Royal Technical College, Salford, 5.

R. RIBBLESDALE THORNTON,
Clerk to the Governors. L 141

THE COLLEGE OF AERONAUTICS.

The Board of Entry of the College invites applications from

SUITABLE CANDIDATES FOR THE TWO-YEAR COURSE which begins in October, 1956, and ends in June, 1958.

Candidates should be of graduate standard although the possession of a degree is not essential; a good Higher National Certificate is an acceptable standard.

The College, a post-graduate institution, is devoted to the study of aeronautical science and engineering. The curriculum covers the five main subjects of Aerodynamics, Aircraft Design, Aircraft Electrical Engineering, Aircraft Propulsion and Aircraft Economics and Production. Instruction in the first year is designed to provide all students with a broad background of knowledge in all these subjects, with opportunity for limited specialisation in two or three of them. In the second year, students specialise more particularly, usually in one subject.

Experiments in the air are an important part of the work, both in the first year when all students take part in them and in the second year when they are linked to the specialist work of the departments.

Students who satisfactorily complete the course will receive the Diploma of the College.

Further particulars and details of the procedure for enrolment may be obtained from:

THE WARDEN,
THE COLLEGE OF AERONAUTICS,
CRANFIELD,
BLETCHLEY,
BUCKS. L 164

ROYAL TECHNICAL COLLEGE, SALFORD.

DEPARTMENT OF MECHANICAL ENGINEERING.

ACTING HEAD OF DEPARTMENT: W. F. FISH, M.A., Wh.Sc., A.M.I.Mech.E.

SUMMER SCHOOL IN PRODUCTION ENGINEERING ENTITLED "MACHINE SHOP EFFICIENCY."

A Post-advanced School under this title has been arranged to take place during the period 23rd to 27th July, 1956, both dates inclusive. The subjects to be covered by the course are:—

(1) PRODUCTION CONTROL AND THE MEASUREMENT OF MACHINE SHOP EFFICIENCY.
(2) PROBLEMS OF LARGE JOBBING MACHINE SHOP, THE MEDIUM-LARGE BATCH MACHINE SHOP AND THE MASS PRODUCTION MACHINE SHOP.
(3) RELATIONSHIP BETWEEN MACHINE SHOP EFFICIENCY AND METAL CUTTING RESEARCH.
(4) JIGS, TOOLS AND FIXTURES.
(5) MODERN DEVELOPMENTS IN MACHINING TECHNIQUE.
(6) RESERVICING OF CUTTING TOOLS.
(7) PRESENT TRENDS IN MACHINE TOOL USAGE AND DESIGN. SEMI-AUTOMATIC AND AUTOMATIC MACHINE TOOLS.
(8) THE USE OF CUTTING MATERIALS: HIGH SPEED STEEL, CAST ALLOYS AND TUNGSTEN CARBIDE.
(9) MECHANICAL AND MATERIALS HANDLING PROBLEMS.
(10) LAY-OUT OF MACHINE SHOPS: STANDARDISATION, SIMPLIFICATIONS, ETC.

Further details and forms of application may be obtained from the ORGANISING LECTURER, L. MILLER, ROYAL TECHNICAL COLLEGE, SALFORD, 5.

R. RIBBLESDALE THORNTON,
Clerk to the Governors. L 140

BRITISH IRON AND STEEL FEDERATION.

MANAGEMENT TRAINING.

The British Iron and Steel Federation proposes to arrange a **SERIES OF RESIDENTIAL COURSES** for managers nominated by companies in the industry and is seeking to recruit additional members of staff to take part in organising and conducting courses and preparing material for study.

There will be vacancies for:—

(a) A cost and works accountant with good qualifications and with experience in the iron and steel industry.
(b) A metallurgist with good qualifications and with production experience in the industry.
(c) An engineer with good qualifications and with knowledge of the operation and maintenance of steelworks plant.
(d) A man with experience of and interest in management development.

In the case of each of these posts the salary offered will be related to the experience and potential of the successful candidate. The appointments will be tenable in Sheffield.

Applications, which should include in full statement of past experience, should be sent to the BRITISH IRON AND STEEL FEDERATION, HOYLE STREET, SHEFFIELD, 3. L 192

EXPERIMENTAL WORK.

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Northampton Grove, Canonbury, London, N.1. Canonbury 4244/5/6. We have over 25 years' experience of experimental work and prototypes. We design, develop and manufacture special purpose and labour saving machines, all at the above address. Our range is from the smallest scientific instruments to 3- or 4-ton machines. After a prototype machine has been made and found satisfactory we can manufacture as many as are required. G 656

TENDERS.

THE HIGH COMMISSIONER FOR INDIA invites **TENDER** for the supply of:—

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PLATE STEEL OF VARIOUS SIZES AND SPECIFICATIONS ... ... TO I.R.S. SPECIFICATIONS No. R21, R29, M-5.	376

Forms of tender may be obtained from the DIRECTOR-GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, on or after 17th April, 1956, at a fee of 10s. which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m. on Tuesday, 22nd May, 1956.

Please quote reference No. 439/55/RLY. L 179

LINDSEY COUNTY COUNCIL HIGHWAYS DEPARTMENT.

(1) CONSTRUCTION OF KEADBY LOCK SWING BRIDGE, B1392.
(2) ALTERATIONS TO BARDNEY JOINT BRIDGE B1199.

TENDERS are invited for the above works which are situated some 40 miles apart.

1. Keadby Lock Swing Bridge is situated on the Sheffield and South Yorkshire Canal in the village of Keadby four miles west of Scunthorpe. The works consist of the construction of a new reinforced concrete substructure, including piling, and the provision and erection of an electrically operated welded steel swing bridge together with all controls and ancillary works.

2. Bardney Bridge is a 100 ft. span lattice girder bridge over the River Witham 10 miles east of Lincoln and the works consist of strengthening by means of piled concrete supporting frames and a new welded steel plate deck, together with a new cantilevered footway.

Contract documents are obtainable from MESSRS. WILTON & BELL, 25, VICTORIA STREET, S.W.1, on payment of £3 deposit for each set returnable for a bona fide tender. Plans, etc., may be inspected at the offices of the Consultants or the undersigned.

Tenders MUST be received by the undersigned by 10 a.m. on Saturday, 2nd June, 1956, in a sealed envelope marked "Keadby Lock Swing Bridge," and/or "Bardney Joint Bridge," and may be submitted for either or both contracts.

The Council do not bind themselves to accept the lowest or any Tender.

G. K. TALLACK, A.M.I.C.E.,
COUNTY SURVEYOR.

COUNTY OFFICES,
LINCOLN. L 92

THE HIGH COMMISSIONER FOR INDIA invites **TENDERS** for the supply of:—

	QUANTITY Nos.
SUPERHEATERS:—	
Superheater Headers for Locomotive Boilers	17
Superheater Elements for Locomotive Boilers	1,197

Forms of tender may be obtained from the DIRECTOR-GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, on or after 17th April, 1956, at a fee of 10s. which is not returnable. If payment is made by cheque, it should please be made payable to "High Commissioner for India." Tenders are to be delivered by 2 p.m., on Friday, 18th May, 1956.

Please quote reference No. 234/55/RLY. L 178

THE HYDRO-ELECTRIC COMMISSION. TASMANIA.

WAYATINAH "A" POWER DEVELOPMENT.

TENDERS FOR CREST GATE—LIAPOOTAH DAM.

TENDERS will be received by the SECRETARY, THE HYDRO-ELECTRIC COMMISSION, BOX 631 B, G.P.O., HOBART, TASMANIA, until noon on Monday, 6th August, 1956, for the design, supply, fabrication, delivery, supervision of erection and maintenance of one **HYDRAULICALLY OPERATED CREST GATE OF THE LOWERING TYPE, 120 FEET LONG AND APPROXIMATELY 20 FEET HIGH.** Designs by specialist firms only will be considered.

Specification No. C.E. 533 is obtainable on application to the AGENT GENERAL FOR TASMANIA, 457, STRAND, LONDON, W.C.2. L 215

PUBLIC APPOINTMENTS.

CANTERBURY EDUCATION AUTHORITY.

CANTERBURY TECHNICAL COLLEGE.

Applications are invited for the following full-time new appointments, for 1st September, 1956, for this Regional College:

1. **ASSISTANT FOR AUTOMOBILE ENGINEERING WORK** with students taking the Service Mechanics', Technicians', and Electricians' Courses. Ability to help with Agricultural Machinery would be an additional recommendation. Qualifications: City and Guilds Full Technological Certificate; recent industrial experience in the Motor Vehicle Repair Trade essential.

2. **ASSISTANT FOR ELECTRICAL INSTALLATION WORK** with students taking Courses "B" and "C" of the City and Guilds. Qualifications: City and Guilds Course "B" and Course "C" Certificates, together with Ordinary National Certificate in Electrical Engineering. Industrial experience essential. A knowledge of flameproof equipment an additional recommendation.

The appointments are Grade "A" on the Burnham Scales for Establishments for Further Education, i.e., £450 by £18 to £725 per annum, with appropriate allowances for Degree, training and approved industrial experience.

Excellent opportunities for advancement exist in this rapidly developing Regional College for which an extensive building programme is approved.

Further particulars and Forms of Application, which should be returned as soon as possible, may be obtained from the PRINCIPAL, TECHNICAL COLLEGE, LONGPORT, CANTERBURY.

N. POLMEAR,
CHIEF EDUCATION OFFICER.

EDUCATION OFFICES,
78 LONDON ROAD,
CANTERBURY, KENT. L 60

DERBY AND DISTRICT COLLEGE OF TECHNOLOGY.

PRINCIPAL: T. HEAP, Ph.D., M.Sc., F.R.I.C., A.M.I.I.A.

Applications are invited for the post of **HEAD OF MECHANICAL ENGINEERING DEPARTMENT**, duties to commence on 1st September, 1956.

Candidates must be graduates with good industrial experience and should have had wide teaching and organising experience in Technical Colleges or a University. Applications will be accepted from well qualified senior lecturers.

Salary will be in accordance with the Burnham Further education scales for Heads of Departments, either Grade IV (£1365 by £25 to £1515 p.a.) or Grade V (£1515(by £25 to £1665 p.a.) according to qualifications and experience.

Application forms and details of the post can be obtained from the PRINCIPAL, DERBY AND DISTRICT COLLEGE OF TECHNOLOGY, NORMANTON ROAD, DERBY, by whom completed applications should be received not later than 7th May, 1956. L 184

ADMIRALTY.

ROYAL NAVAL SCIENTIFIC SERVICE require **SENIOR SCIENTIFIC OFFICERS** and **SCIENTIFIC OFFICERS** in Experimental Establishments chiefly in Weymouth, Cheltenham and Portsmouth areas and Home Counties. Majority of posts for Electronic Engineers, Physicists (particularly with Electronics), and Mechanical Engineers with design experience in light mechanisms including servo-mechanisms, knowledge of hydraulics an advantage. Candidates must normally be natural born British subjects of natural born British parents with first or second class honours degree or equivalent high professional attainments. Salaries (Men) S.S.O., £1070-£1245; S.O., £513-£925, London rates. Somewhat lower in Provinces. Appointments unestablished (with F.S.S.U.), some opportunities to compete for established posts.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting A 344/5A. L 7

THE PAISLEY TECHNICAL COLLEGE.
(CENTRAL INSTITUTION).

Applications are invited for the following appointments:

MECHANICAL ENGINEERING:
SENIOR LECTURER: Salary scale, £1010 by £50 to £1210.
GRADE I LECTURER: Salary scale, £760 by £30 to £910 by £50, to £1060 by £50 to £1160.
GRADE IIA LECTURER: Salary scale, £690 by £30 to £990.
CIVIL ENGINEERING:
GRADE IIA LECTURER: Salary scale, £690 by £30 to £990.

Applicants for the Senior Lecturer and Grade I posts should have industrial or research and teaching experience at university degree or H.N.C. level. For the Grade IIa posts applicants need not have teaching experience. All applicants should have an honours degree or equivalent qualification. The salary scales are under immediate review which will apply as from 1st April, 1956. Successful applicants will be given a placing on the scales appropriate to approved experience. Further particulars may be obtained from the undersigned.

H. N. HENRY,
PRINCIPAL. L 33

MINISTRY OF SUPPLY requires **ENGINEERS** at Chorley, Lancs., to form a team working on mechanical and electrical equipment for novel plant of chemical engineering nature. Vacancies cover various aspects such as design and specification, ancillary services (electrical, building works, etc.), manufacture, progressing, inspection, installation, etc., and are in three grades at salaries ranging within £675 (age 25) to £1575 p.a.

QUALIFICATIONS: A.M.I.C.E. or Mech.E. or E.E. or exempting qualifications. A recognised engineering apprenticeship, and appropriate experience. Application forms from M.L. & N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C303/6A. L 210

THE SUPERVISOR'S GUIDES—No. 4 Factory Organisation

By J. Munro Fraser, M.A., and B. W. Gould, M.I.PROD.E., A.M.I.E.E. The latest book in a series which has proved immensely popular. It forms a concise guide to factory management produced specially in suitable form for supervisors and foremen. 3s. net.

HYDRAULICS AND THE MECHANICS OF FLUIDS

By E. H. Lewitt, B.SC., PH.D. 9th Edition. This well-known textbook covers the syllabuses of the B.Sc.(Eng.), Inst.C.E., and I.Mech.E., examinations in this subject. Illustrated. 30s. net.

THE PROTECTIVE GEAR HANDBOOK

By M. Kaufmann, M.I.E.E. A companion volume to "The Switchgear Handbook." Invaluable to engineers interested in maintaining continuity of supply in distribution networks, to those responsible for planning and designing switchgear installations, and also to students. 35s. net.

FACTORY ADMINISTRATION IN PRACTICE

By W. J. Hiscox and James Stirling, A.M.I.MECH.E. Sixth Edition. This book has been widely adopted throughout the country by educational institutions as a textbook for classes in factory administration and organization. An invaluable book for all members of the factory administrative staff. 12s. 6d. net.

PITMAN **technical books**
Parker Street, Kingsway, London, W.C.2

Instructor Branch Royal Navy

Why not utilise your scientific and professional knowledge and at the same time enjoy the comradeship of service life and see the world with the Royal Navy.

The Instructor branch offers Short Service commissions to graduates in Mathematics, Physics, Engineering, Chemistry, Metallurgy, History and English and to non-graduates with teaching experience in Science subjects.

The work of the Instructor Officer is fundamental to the Fleet and covers the widest field of active operational and academic duties ashore and afloat. Instructor officers are also the meteorologists of the Royal Navy.

Note also:—

★ Undergraduates in final year may apply.

★ Short Service Commissions may be for 3, 4 or 5 years.

★ Taking a Short Service Commission fulfils your obligation for National Service.

★ £300 tax free gratuity after 3 years and *pro rata* for longer.

★ All Short Service Officers may apply for permanent commissions.

★ Candidates must be British subjects, sons of British parents, under 36 years of age and medically fit.

For further details apply to

DIRECTOR,
NAVAL EDUCATION SERVICE (P:E),
ADMIRALTY, LONDON

(PE), K976.

Classified Advertisements continued on Page 4

DERBYSHIRE EDUCATION COMMITTEE.

CHESTERFIELD COLLEGE OF TECHNOLOGY.

PRINCIPAL: E. CARDWELL, M.Sc. (Lond.), Wh.Ex., M.I.Mech.E.

Applications are invited for the full-time post of **ASSISTANT GRADE B,** in the Department of Mechanical and Civil Engineering with effect from the 1st September, 1956. Duties will include teaching for National Certificate Courses in Mechanical and Production Engineering, together with Workshop Technology and Practice up to Final City and Guilds standard in Machine Shop Engineering.

Salary will be in accordance with the Burnham Technical Scale for Assistants, Grade B, with allowances for teaching and approved industrial experience. Further particulars and forms of application from the undersigned (stamped addressed foolscap envelope required) to whom applications should be returned within 14 days of this advertisement.

S. A. BROADWELL,
REGISTRAR.

COLLEGE OF TECHNOLOGY,
INFIRMARY ROAD,
CHESTERFIELD. L 187

UNIVERSITY COLLEGE OF THE GOLD COAST.

Applications are invited for appointment as
(A) ASSISTANT ENGINEER (ELECTRICAL).
(B) ASSISTANT ENGINEER (MECHANICAL).
in the Estate Office.

The duties of the Assistant Engineer (Electrical) will include the operation and maintenance of the EHV and LV underground distribution system, water supply, sewage, institutional and domestic electrical equipment and preparation of schemes and estimates for new installations.

The duties of the Assistant Engineer (Mechanical) will include the operation of the College transport workshops for 100 vehicles, general repair workshops.

Salary in each case will be in the scale £1200 by £50 to £1450 per annum, with point of entry according to experience and qualifications. F.S.S.U. or equivalent gratuity; appointment five years initially; family allowance at the rate of £100 per child (maximum £500); free passages for appointee, wife and maximum of five children, on first appointment and on annual leave; outfit allowance of £60. Part furnished quarters at rent not exceeding 7.5 per cent. of salary.

Applications, (six copies, naming three referees and stating full qualifications and experience to be sent so as to reach the ASSISTANT REGISTRAR (LONDON), UNIVERSITY COLLEGE OF THE GOLD COAST, 29, TAVISTOCK SQUARE, LONDON, W.C.1, or the Registrar, University College of the Gold Coast, Achimota, Accra, not later than a fortnight after the appearance of this notice. L 173

PETERBOROUGH JOINT EDUCATION BOARD.

PETERBOROUGH TECHNICAL COLLEGE.

Applications are invited for two
FULL-TIME TEACHERS OF MECHANICAL ENGINEERING (GRADE B). Applicants should possess a Degree or equivalent and will be required to teach engineering subjects to O.N.C. level.

Salary will be in accordance with the Burnham (Further Education) Scale: Grade B, £525 to £820 per annum, with appropriate allowances for degree, training and industrial experience.

Forms of application (returnable within fourteen days) and further particulars from the CHIEF EDUCATION OFFICER, TOWN HALL, PETERBOROUGH. L 212

PRESTON.

HARRIS INSTITUTE TECHNICAL COLLEGE.

Wanted for September 1956
ASSISTANT LECTURER in Mechanical Engineering with practical experience and ability to teach such subjects as Workshop Technology, Machine Tools, Metrology or Jig and Tool design.

Salary Burnham Scale, Grade B £525 to £820 with increments for degree, training and experience.

Details and Application Forms may be obtained from the undersigned to whom they should be returned with in 14 days of this advertisement.

H. WILKINSON, PH.D., A.INST.P., Principal,
Harris Institute Technical College,
Corporation Street, Preston, Lancs. L 218

NORTHAMPTON POLYTECHNIC, ST. JOHN STREET, LONDON, E.C.1.

Applications are invited for appointments as
LECTURER OR ASSISTANT LECTURER (GRADE B) in the Civil and Mechanical Engineering Department, for teaching in Degree and National Certificate courses as follows:

1. SOIL MECHANICS, with Surveying and other subjects of Civil Engineering courses.
2. Mechanical Engineering subjects including APPLIED THERMODYNAMICS or MECHANICS OF FLUIDS.

The appointments will be made from 1st September, 1956, as Lecturer or Assistant Lecturer (Grade B) according to qualifications. Salaries in accordance with the London Technical Scale:
Lecturer £1001 by £25 to £1113;
Assistant Lecturer (Grade B), £561 by £25 to £868;
with £60 for degree or equivalent qualifications, £18 to £54 for University training and allowance for industrial or teaching experience.

Further particulars and forms of application are obtainable from THE SECRETARY, to whom applications should be sent by 11th May.

J. E. RICHARDSON,
Ph.D., B.Eng., M.I.E.E., A.M.I.Mech.E.
PRINCIPAL. L 224

COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF SUPPLY.

AERODYNAMICS DIVISION.

WEAPONS RESEARCH ESTABLISHMENT, SALISBURY, SOUTH AUSTRALIA.

Applications are invited for a position of
PRINCIPAL SCIENTIFIC OFFICER (A.P. 42/1) at the above Establishment.

SALARY: £2713 to £3043 per annum (Australian currency).

DUTIES: To initiate and be responsible for research, especially of a mathematical nature, in supersonic and transonic flow, and to collaborate with staff carrying out experimental work in this field; and to exercise supervision over the work of other scientific staff.

QUALIFICATIONS: Degree of high standard in Mathematics or equivalent qualifications, extensive experience of theoretical work in supersonic aerodynamics and ability to direct the work of others.

Where permanent appointment is accepted, the appointee will be required to contribute to the Commonwealth Superannuation Scheme. However, the successful applicant may alternatively choose to enter into an agreement for a three (3) to five (5) years contract of employment in Australia. In this case, the Commonwealth will bear the cost of return fare, together with cost of removing each way the appointee's furniture and effects up to a maximum cost of £500 (Australian), £250 (A) each way.

Under specified conditions, first class boat fare (if first class berth available) for the appointee and dependants (wife and dependent children) will be paid by the Commonwealth.

Application forms obtainable from SENIOR REPRESENTATIVE (A.P. 42/1) DEPARTMENT OF SUPPLY, AUSTRALIA HOUSE, STRAND, LONDON, W.C.2, with whom applications should be lodged by 30th April 1956. L 114

LONDON COUNTY COUNCIL.

PADDINGTON TECHNICAL COLLEGE.

ASSISTANT GRADE B. to teach mechanical engineering subjects of Ordinary and Higher National Certificates. Burnham (F.E.) salary scale £525 × £25 to £964 plus London Allowance. Individual commencing and maximum salary according to age, qulifications and experience. Application forms from SECRETARY AT COLLEGE, SALTRAM CRESCENT, W.9, returnable by 2nd May. (605). L 134

NATIONAL COAL BOARD, OPENCAST EXECUTIVE, has vacancies for
CIVIL ENGINEERS for work in connection with the preparation, letting and supervision of contracts for opencast coal working. Applicants should have had practical experience in the conduct of large civil engineering works in the field, and a recognised technical qualification in Civil Engineering is desirable.

Commencing salary will be according to qualification and experience within a salary rage of £875 to £1125 per annum. The appointments are superannuable, and opportunities will exist for promotion of the right men to higher grades. Applications giving full details of age, qualifications and experience should be made to the ESTABLISHMENTS OFFICER, NATIONAL COAL BOARD, OPENCAST EXECUTIVE, 85/87, JERMYN STREET, LONDON, S.W.1, within 10 days. L 154

WARWICKSHIRE EDUCATION COMMITTEE.

RUGBY COLLEGE OF TECHNOLOGY AND ARTS.

In connection with Industry-based Sandwich Courses in Engineering and other developments, the following appointments to the College staff are being made from 1st September, 1956.

Department of Mechanical Engineering.
1 SENIOR LECTURER.
3 ASSISTANTS, GRADE B.

For the Senior Lecturer post, candidates should be graduates of a University; corporate membership of the Institution of Mechanical Engineers, with adequate teaching and industrial experience, is also expected. The lecturer appointed would also be required to teach in Higher National Certificate, Professional and Degree courses.

For the Grade B posts candidates should be graduates and/or hold professional qualifications. The successful applicants would be required to teach Ordinary National Certificate and City and Guilds students.

Salaries will be in accordance with the Burnham Technical Scale, with appropriate additions for qualifications and experience.

Application form and further particulars may be obtained by sending a stamped addressed foolscap envelope to the undersigned, by whom applications should be received as soon as possible.

W. COOPER,
PRINCIPAL.

RUGBY COLLEGE OF TECHNOLOGY AND ARTS,
EASTLANDS,
RUGBY. L 78

ST. EDWARDS (MENTAL) HOSPITAL, CHEDDLETON, NR. LEEDS, STAFFS.
(1,450 Beds).

SUPERINTENDENT ENGINEER AND CLERK OF WORKS required. Salary £810 by £25 by £30 (4) to £955. Must have passed an examination in engineering technology and hold one of the following qualifications, or an approved equivalent certificate: Higher National Diploma (or Certificate) in Mechanical Engineering, or First Class Certificate of competency in Marine Engineering or equivalent Naval Certificate. Must be competent to undertake the duties of Clerk of Works of the Building Maintenance Department. The person appointed will be required to reside in the house provided on the hospital estate for which a rental will be charged. Applications with names of two referees by 27th April, to THE GROUP SECRETARY. L 213

CARMARTHENSHIRE EDUCATION COMMITTEE.

LLANELLY TECHNICAL COLLEGE.

Applications are invited for the post of
FULL-TIME ASSISTANT MASTER IN PRODUCTION ENGINEERING at the above-named College.

Candidates should be graduates in Engineering or be Corporate Members of the Institution of Production Engineers, with industrial experience, and preferably some teaching experience.

Salary in accordance with the Burnham Further Education Report, 1954, for Grade B Assistants, including allowances for teaching and approved industrial experience.

Duties to commence as soon as possible.

Further particulars and forms of application, which must be returned within TWO weeks of the appearance of this advertisement, may be obtained from the undersigned on receipt of a stamped addressed envelope.

IORWERTH HOWELLS,
DIRECTOR OF EDUCATION.

COUNTY EDUCATION OFFICES,
COUNTY HALL,
CARMARTHEN. L 77

ROYAL MILITARY ACADEMY, SANDHURST.
LECTURERS OR SENIOR LECTURERS.
The Civil Service Commissioners invite applications from men for the following posts: (*a*) two in Modern Subjects, (*b*) one or two in Mathematics, (*c*) at least two in Science. Under (*a*) the posts are short service and as Lecturers, under (*b*) one post is long service (i.e. pensionable) as Lecturer or Senior Lecturer, the other would be short service as Lecturer or Senior Lecturer, under (*c*) the posts are short service and as Lecturers or Senior Lecturers. Candidates selected for short service posts will be considered for long service posts as they arise and the period as a short service member will normally count for superannuation purposes.

Age at least 21 on 1st August, 1956, but appointment to a Senior Lecturership is not normally made under the age of 30. Candidates must have (or obtain in Summer, 1956) an appropriate degree (at least 2nd Class Honours) or equivalent. Teaching experience is desirable and appointment to a Senior Lecturership will depend largely upon academic qualifications and teaching experience.

Salary scales: Lecturer—£483 to £909; Senior Lecturer—£960 to £1255. Provision for starting salary above the minimum.

Successful candidates expected to take up duty by September, 1956, or as soon after as possible.

Further particulars and application forms from SECRETARY, CIVIL SERVICE COMMISSION, BURLINGTON GARDENS, LONDON, W.1, quoting No. 4580/56/15. Application forms must be returned by 4th May, 1956. L 211

CITY OF LEICESTER.

EDUCATION COMMITTEE.

COLLEGE OF TECHNOLOGY AND COMMERCE.

PRINCIPAL: R. E. WOOD, M.Sc., F.Inst.P.

Applications are invited for the post of
ASSISTANT LECTURER (GRADE B) in the Department of Electrical Engineering, for Ordinary National Certificate and Electrical Installation courses.

Candidates should possess a Higher National Certificate or City and Guilds of London Institute "C" Certificate and should have had adequate practical experience in Electrical Installation Work.

Salary: Burnham Technical Scale £525 by £25 to £820 per annum, with appropriate allowances for industrial experience.

Forms of application can be obtained from the REGISTRAR, COLLEGE OF TECHNOLOGY & COMMERCE, THE NEWARKE, LEICESTER, to whom completed forms should be returned as soon as possible.

ELFED THOMAS,
DIRECTOR OF EDUCATION. L 214

AIR MINISTRY Works Designs Branch requires (A) in LONDON.
(1) DESIGNER/DRAUGHTSMEN (Order No. 1005) for bulk petroleum storage and pumping installations experienced in one or more of the following:—
(*a*) Storage tank layout and design, (*b*) pump house and plant layout, (*c*) development of pipe line schemes, (*d*) hydraulic calculations. Technical training to O.N.C. standard required. Salaries up to £725 p.a.
(2) STRUCTURAL ENGINEERING DESIGNER/DRAUGHTSMEN (Order No. 1001) for reinforced concrete or structural steel work with sound technical training and several years varied experience in design/detailing of:—
(*a*) Reinforced concrete construction for all types of buildings, or (*b*) steel framed sheds, warehouses and similar buildings, and
CIVIL ENGINEERING DESIGNER/DRAUGHTSMEN (Order No. 1002) experienced in one or more of the following branches of engineering:—
(*a*) Earthworks and Stormwater Drainage, (*b*) Foul Drainage and small disposal works, (*c*) Water Pumping Treatment and Distribution. Salaries up to £850 p.a.
(B) IN LONDON AND PROVINCES (with liability for overseas service)
ELECTRICAL ENGINEERING DRAUGHTSMEN (Order No. 1004) experience in preparation of schemes for illumination and electrical equipment of buildings or in electrical distribution H.V. and M.V. Technical training to O.N.C. standard or equivalent and advantage. Salaries up to £850 p.a. Starting pay dependent upon age quals. and experience. Paid overtime. Long term possibilities with pensionable and promotion prospects. Four weeks' leave a year. Normally natural born British subjects. Write stating age, quals., employment details incl. type of work done to any Employment Exchange quoting Borough and relevant Order No. G 657

Surveying for Civil Engineers

PHILIP KISSAM Professor of Civil Engineering, Princeton University

The engineer directing important or unusually accurate surveys must be familiar with every special instrument or technique which might be used to save time and money. This book provides a practical, economic approach to advanced methods; it is suitable for students who have already taken an introductory course in the basic principles of surveying.

9 x 6 inches 764 pages 64 shillings

Construction . . . planning, equipment and methods

R. L. PEURIFOY Professor of Construction Engineering Texas Agricultural and Mining College
McGraw-Hill Series in Civil Engineering

This book, which treats the subject of construction on an engineering basis, may be used as a textbook by students of architecture and engineering. It will also be a useful guide for professional engineers, architects and builders when designing or purchasing equipment, writing specifications and choosing methods of construction.

9 x 6 inches 558 pages 64 shillings

McGRAW-HILL *from your usual bookseller*

MINISTRY OF LABOUR AND NATIONAL SERVICE:

H.M. INSPECTORS OF FACTORIES (CLASS II). The Civil Service Commissioners invite applications from men and women for pensionable posts. Age at least 21 and (unless exceptionally well qualified) under 30 on 1st June in the year of application with extension for regular service in H.M. Forces. London salary (including extra duty allowance where payable) £506 (at age 21), then according to age up to £689 at 26 or over, rising to £917. Somewhat lower outside London. A special increment of £25, within the scale, is granted after passing probation. Higher posts filled by promotion from Class II.

Duties include the enforcement of the provisions of the Factories Acts and Regulations affecting the safety, health and welfare of work-people and extend to all manufacturing industries and to certain other places, including Docks, Works of Engineering Construction and Building Operations.

Candidates must normally be university graduates, preferably in Engineering or Natural Science (or comparable technical qualification, e.g., A.M.I.Mech.E.). Graduates in other subjects, including Arts, are eligible. Works or other practical experience an advantage. Candidates without degrees (or comparable technical qualifications) who have good general or technical qualifications, and have had considerable works or other practical experience (especially in responsible positions) will also be considered.

Application may be made at any time, and so long as there are vacancies suitable candidates will be interviewed.

Particulars from SECRETARY, CIVIL SERVICE COMMISSION, 6, BURLINGTON GARDENS, LONDON, W.1, quoting No. 280. L 209

THE UNIVERSITY OF LIVERPOOL.

HENRY BELL WORTLEY CHAIR OF METALLURGY.

The Council of the University invites applications for the Henry Bell Wortley Chair of Metallurgy. The salary will be not less than £2100 per annum. Further particulars may be obtained from the undersigned by whom twelve copies of applications (one in the case of overseas candidates) should be received not later than 26th May, 1956.

STANLEY DUMBELL,
REGISTRAR. L 76

LIVERPOOL REGIONAL HOSPITAL BOARD.

Applications invited from suitably qualified persons for permanent superannuable post of **DEPUTY REGIONAL ENGINEER,** Regional Engineer's Department, 2 Union Street, Liverpool, 3.

Candidates must be Corporate Members of the Institution of Civil Engineers or Mechanical Engineers or Electrical Engineers or Structural Engineers and must have had wide experience in engineering design and operation, preferably in connection with hospitals and institutions.

The person appointed will be required to deputise for the Regional Engineer over the whole engineering field and undertake under his direction the design and supervision of engineering projects and preparation of technical reports.

Salary £1195 by £50(4) by £30(1) to £1425. The appointment will be determinable by three calendar months notice.

Applications stating age, qualifications, experience, present and previous appointments together with names and addresses of three referees (two technical), to reach me at 19, JAMES STREET, LIVERPOOL, 2, by 25th April, 1956.

VINCENT COLLINGE,
Secretary to the Board. K 227

ROYAL TECHNICAL COLLEGE, SALFORD.

PRINCIPAL: P. F. R. VENABLES, B.Sc., Ph.D., F.R.I.C.

The Governors invite applications for the post of **HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT,** duties to commence as soon as possible. The post is recognised as a Grade V Department under the 1954 Burnham Committee Report (Technical); the salary is £1515, by annual increments of £25 to £1665, but may be subject to upward revision under the forthcoming new Burnham Report.

Candidates should preferably have teaching, industrial and/or research experience, and be capable of taking charge of a large and growing department in a period of transfer to new extensions now being built. They should also be able to direct the growing volume of post-graduate courses and to develop research in the department.

Forms of application, together with further particulars of the post, may be obtained from THE PRINCIPAL, ROYAL TECHNICAL COLLEGE, SALFORD, 3, to whom they should be returned as soon as possible.

R. RIBBLESDALE THORNTON,
CLERK TO THE GOVERNORS. L 188

CITY OF NOTTINGHAM.

WATER DEPARTMENT.

CIVIL ENGINEERING ASSISTANT.

Applications for this permanent, pensionable appointment are invited from **ENGINEERING GRADUATES,** and should be sent to the Engineer and General Manager, Water Department, Castle Boulevard, Nottingham, by the 26th April next, with the names of two persons to whom reference may be made. Salary in accordance with Grade APT. II of the National Scale, viz., £585 by £20 to £675, or, in the case of Graduates who have had at least five years' satisfactory experience, £690 by £30 to £840.

T. J. OWEN,
TOWN CLERK.

GUILDHALL,
NOTTINGHAM. L 113

COMMISSIONERS OF IRISH LIGHTS.

Applications are invited for the established post of **ASSISTANT (ELECTRICAL)** to the Manager of the Commissioners' Workshops at Dun Laoghaire, County Dublin.

Candidates should be between the ages of 25 and 35 years of age, be works trained in an electrical or radio engineering firm of repute and have had some drawing office experience.

A thorough working knowledge of electricity (A.C. and D.C. up to 500 V.), electrical test equipment and communication engineering is essential.

Candidates should have passed Parts I and II of the Examination of the Institution of Electrical Engineers or hold equivalent qualifications.

The consolidated salary scale is £635 by £25 to £885 per annum, which is subject to a cost-of-living bonus which at present brings the scale to £815 to £1122 per annum.

Applications, giving full particulars of age, education, training, experience and qualifications are to be submitted not later than Monday, 7th May, 1956, to the undersigned, from whom further particulars of the appointment and conditions of service may be obtained.

A. J. ENGLAND,
SECRETARY.

IRISH LIGHTS OFFICE,
28, D'OLIER STREET,
DUBLIN. L 101

COUNTY BOROUGH OF DONCASTER.

ENGINEERING ASSISTANT.

Applications are invited for the appointment of an **ENGINEERING ASSISTANT (MECHANICAL)** to supervise the installations, maintenance and repairs of mechanical plant and equipment at the Sewage Disposal Works, Public Baths, Water and Highways Departments, at a salary to be fixed according to the candidates abilities, experience and qualifications.

Applications stating age, qualifications (if any), present appointment and salary, previous appointments and full details of experience, together with the names and addresses of two referees, should be sent to the Borough Engineer and Surveyor, 2, Priory Place, Doncaster, Yorks, on or before Saturday, 28th April, 1956.

Candidates must state, in writing, whether they are related to any member or senior officer of the Council.

H. R. WORMALD,
TOWN CLERK.

1, PRIORY PLACE,
DONCASTER. L 109

THE BRITISH SHIPBUILDING RESEARCH ASSOCIATION has a vacancy in the Marine Engineering Section for a **PERSON WITH A GOOD UNIVERSITY DEGREE IN MARINE OR MECHANICAL ENGINEERING** and with practical training and experience. Research experience and/or service at sea an advantage.

The salary will be within the range of £550 to £1350 per annum. The commencing salary will, however, depend upon age and qualifications. The appointment is subject to the Federated Superannuation System for Universities.

Applications with full particulars should be addressed to THE SECRETARY, THE BRITISH SHIPBUILDING RESEARCH ASSOCIATION, 5, CHESTERFIELD GARDENS, CURZON STREET, LONDON, W.1. L 110

THE BRITISH SHIPBUILDING RESEARCH ASSOCIATION has vacancies in the Naval Architecture Section for **PERSONS WITH EITHER A DEGREE IN NAVAL ARCHITECTURE, HIGHER NATIONAL CERTIFICATE OR EQUIVALENT QUALIFICATIONS,** and with apprenticeship or practical experience in shipbuilding.

The salaries will be within the range of £500 to £1000 per annum. The commencing salaries will, however, depend upon age and qualifications. The appointments are subject to the Federated Superannuation System for Universities.

Applications with full particulars should be addressed to THE SECRETARY, THE BRITISH SHIPBUILDING RESEARCH ASSOCIATION, 5, CHESTERFIELD GARDENS, CURZON STREET, LONDON, W.1. L 111

CENTRAL ELECTRICITY AUTHORITY.

MIDLANDS DIVISION.

Applications are invited for the following positions in the Generation Construction Department at Divisional Headquarters, Moseley, Birmingham. Good working conditions, superannuable appointments, salaries within the range £640 to £850 per annum, dependent upon qualifications and experience:—

(A) SENIOR DRAUGHTSMAN (MECHANICAL). Vacancy No. 266MD.
(B) SENIOR DRAUGHTSMAN (MECHANICAL). Vacancy No. 267MD.
(C) SENIOR DRAUGHTSMAN (ELECTRICAL). Vacancy No. 268MD.

Applicants should have a sound technical training and experience appropriate to the position applied for, i.e., the layout of either

(*a*) boilers, ash and coal handling plant, factory services and ancillary equipment, or
(*b*) turbo-alternator, heavy pumping plant, H.P. steam and feed pipework, and ancillary equipment, or
(*c*) electrical plant, transformers, switchgear and associated main and control cabling, preferably, but not essentially, associated with power station, chemical or other heavy industrial plant.

The Division is responsible for the installation of power station plant of advanced design, offering a variety of interesting, and frequently novel, work.

Apply, quoting the vacancy number, on form AE6, available from the ESTABLISHMENTS OFFICER, 53, WAKE GREEN ROAD, MOSELEY, BIRMINGHAM, 13, by 30th April, 1956. L 87

ENGINEERS (MAIN & BASIC GRADES)

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKSHIRE,

to design or assist in design of general engineering equipment to meet scientists requirements. Applicants should have served a recognised engineering apprenticeship and be Corporate members of the Institution of Mechanical, Electrical or Civil Engineers or have equivalent qualifications.

SALARY: Main Grade £1130 to £1435 p.a. (Male).
Basic Grade £728 (at age 25) to £1130 (Male).

Contributory Superannuation Scheme. Successful married officers now living outside the Establishment's transport area will be eligible for housing on one of the Authority's estates; until housed a lodging allowance may be payable.

Alternatively assistance towards legal expenses incurred in house purchase may be available.

Requests for application forms by POSTCARD to SENIOR RECRUITMENT OFFICER, at the above address, quoting number 1096/26 not later than 24th April. L 136

Applications are invited for the post of **PROFESSOR AND HEAD OF DEPARTMENT OF POWER ENGINEERING** at the Institute of Science, Bangalore, under UNESCO'S Programme of Technical Assistance to underdeveloped countries. Duties to administer Power Engineering Department and co-ordinate activities of the four Sections—Electrical Engineering, Mechanical Enbineering, Civil and Hydraulic Engineering and High Voltage Engineering; lecture to students of post-graduate diploma courses in Electrical Technology and Power Engineering; guide students' research and handle research problems relating to the Electrical Industry. Qualifications: degree in Electrical Engineering, practical training in well-known electrical manufacturing concerns or large power projects, and full corporate membership of Institution of Electrical Engineers. Teaching and research experience desirable. Duration one year, renewable. Salary: £3125 to £3395 per annum tax free, plus allowances. Free return passages for appointee and dependents. For further information and application forms write MINISTRY OF LABOUR AND NATIONAL SERVICE (A.8.12) ALMACK HOUSE, KING STREET, LONDON, S.W.1, quoting A12/15/UNE/IND. L 112

LONDON ELECTRICITY BOARD.

CIVIL/STRUCTURAL ENGINEERING ASSISTANTS AND DRAUGHTSMEN.

Applications are invited for the above positions in the Construction Branch of the Chief Engineer's Department in Central London.

Conditions of service are in accordance with the National Joint Board agreement, Schedule " D," and salaries are inclusive of London Allowance.

Applicants for the positions of Assistants should have experience in the design and detailing of reinforced concrete for foundations, framed buildings, etc., or in the design and detailing of structural steelwork for buildings, etc. Salary within Grade 5 = £672 to £777 per annum.

Applicants for the positions of Draughtsmen should have experience in the preparation of drawings for either reinforced concrete or structural steelwork, or building work. Salary within Grade 6 = £535 10s. to £661 10s. per annum.

Application forms obtainable from PERSONNEL OFFICER, 46, NEW BROAD STREET, LONDON, E.C.2. Please quote ref.: PER/V/2003/FF. L 85

CITY OF NOTTINGHAM.

ASSISTANT QUANTITY SURVEYOR, GRADE APT. V (£795 to £970 per annum).

Applications are invited for the above position in the City Engineer's Department.

Applicants should be Associates of the Royal Institution of Chartered Surveyors, or have extensive professional experience. The person appointed will be required to be responsible for all the Quantity Surveying work on individual major contracts. Commencing salary will be according to experience.

Housing accommodation is available.

Applications on forms to be obtained from R. M. FINCH, O.B.E., M.I.C.E., CITY ENGINEER AND SURVEYOR, GUILDHALL, are to be returned to him ten days after the appearance of this advertisement.

R. M. FINCH,
CITY ENGINEER AND SURVEYOR.
L 196

HER MAJESTY'S OVERSEA CIVIL SERVICE.

MECHANICAL ENGINEER.
P.W.D., NYASALAND.
(BCD 112/4/019).

Executive and supervisory duties concerned with technical aspects of Public Works Department plant and transport organisation, including field maintenance of wide range of contractors plant and vehicles, organisation of workshops, inspections, costing.

Appointment pensionable, salary range £980 to £1850 p.a. commencing salary according to experience. Free passages for officer, wife and assisted passages for children up to the cost of one adult passage. Quarters provided when available, at 7½ per cent. of salary, maximum £150 per annum. Five days leave for each month of resident service.

Candidates, aged 30 to 35, should be A.M.I.Mech.E. with at least 5 years practical experience in mechanical workshops in an executive capacity.

Apply in writing to the DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, giving briefly age, qualifications and experience. Mention the reference number BCD 112/4/019. L 129

BRITISH GUIANA
PUBLIC WORKS DEPARTMENT AND DRAINAGE AND IRRIGATION DEPARTMENT

ENGINEERS (CIVIL)

Appointment on contract/gratuity terms. Salary in incremental scale £1100 to £1400 p.a. Free passages: generous home leave: low income tax: gratuity at the rate of 22½ per cent. of basic salary is payable either at the end of the contract or at intervals of six months.

Candidates should hold a University degree or diploma recognised as exempting from or have passed the Final Parts I and II of the A.M.I.C.E. examination plus at least two years' experience in large Civil Engineering works. Experience in the use of mechanical earth-moving equipment an advantage.

Apply in writing to DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1. Give brief details of age, qualifications and experience. Quote reference BCD 112/30/08/D5. L 130

ADEN.

AGRICULTURAL DEPARTMENT.

ASSISTANT IRRIGATION ENGINEERS.

Appointment is on Contract/Gratuity terms for an initial period of 18-24 months. Salary £1000 plus an overseas allowance varying from £132 to £180 p.a., and a gratuity at the rate of £150 p.a. Free passages. Free medical attention for Officer. Generous home leave. Low Income Tax.

Candidates should be graduate members of the Institution of Civil Engineers or equivalent. Experience with a River Board an advantage. These posts offer opportunities for graduate engineers to obtain the practical experience necessary for election to the Institution of Civil Engineers.

Apply in writing to DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1. Give brief details of age, qualifications and experience. Quote reference BCD. 63/2/05/D5. L 131

TECHNICIAN

required by the

ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKS,

to be responsible for the operation and maintenance of a static sub-station and of a high and low tension distribution network of underground cables and for the running of a maintenance of all power auxiliary plant. These duties will include the supervision of industrial staff and the preparation of normal power station statistics. Applicants should have served a recognised engineering apprenticeship and have had previous experience of the above type of duties including experience on H.T. electrical generation and steam turbo-alternators in synchronism. They should be familiar with the application of the rules for safe working and be qualified to act as an authorised person. Possession of O.N.C. in electrical engineering or equivalent qualification is desirable. Duties may involve shift working.

SALARY: £743—(at age 30) to £873 p.a. (Male). Contributory Superannuation scheme. Successful married officers now living outside the Establishment's transport area will be eligible for housing on one of the Authority's estates. Alternatively assistance towards legal expenses incurred in house purchase may be available; until housed a lodging allowance may be payable.

Requests for application forms by POSTCARD to the SENIOR RECRUITMENT OFFICER at the above address not later than 26th April. Quote reference A737/26. L 135

Classified Advertisements continued on Page 6

ESSEX.

SOUTH-EAST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART, DAGENHAM.

Required in September, 1956:—

(A) LECTURERS (2) IN MECHANICAL ENGINEERING to teach the Higher National Certificate subjects of Materials, Machines or Hydraulics.

(B) GRADE B ASSISTANT IN ELECTRICAL ENGINEERING for National Certificate, Electrical Installation and Electrical Technician Courses.

(C) GRADE B ASSISTANT IN MECHANICAL ENGINEERING to teach Applied Mechanics and Engineering Drawing. Ability to offer Production Engineering subjects an additional advantage.

(D) GRADE B ASSISTANT IN PRODUCTION ENGINEERING for National Certificate and City and Guilds Machine Shop Courses.

Salaries in accordance with the Burnham Further Education Report, 1954, namely:—

Lecturer—£965 by £25 to £1065, plus London Allowance.

Grade B Assistant—£525 by £25 to £820, plus London Allowance and additions for graduation or equivalent qualification and training. Increments on the scale allowed for teaching service, war/national service and approved industrial experience.

Details and forms from the CLERK TO THE GOVERNORS AT THE COLLEGE (stamped addressed foolscap envelope) to whom completed applications should be returned within 14 days of this advertisement. L 183

LONDON COUNTY COUNCIL.

ARCHITECT'S DEPARTMENT.

Vacancies for

ENGINEERING ASSISTANTS (up to £818) and **ENGINEER GRADE III** (up to £987) in the Structural Engineering Division. Work includes steelwork and reinforced concrete design and detailing for Council's buildings. Particulars and application forms from ARCHITECT (AR/EK/SE/1) THE COUNTY HALL, S.E.1. (1278). G 573

THE BERMUDA ELECTRIC LIGHT COMPANY, LTD.

ASSISTANT POWER STATION SUPERINTENDENT.

Applications are invited for the above post in the Company's power station which contains 18,000 kW of diesel engine plant. Candidates should be between 25 and 35 years of age, be A.M.I.Mech.E. or possess equivalent qualifications and experienced in oil engine operation and maintenance. There are good opportunities of advancement for an engineer willing to make his home in Bermuda.

Applications, giving full details of qualifications, etc., should be addressed to MESSRS. MACKNESS & SHIPLEY, PARLIAMENT MANSIONS, ABBEY ORCHARD STREET, WESTMINSTER, S.W.1, from whom further particulars can be obtained. L 167

STATES OF JERSEY.

SEWERAGE BOARD.

Applications are invited for appointments in the office of the Consultant Engineer to the Sewerage Board, as follows:—

(a) **AN ASSISTANT ENGINEER** at a commencing salary within the range £900 to £1000 a year. The principal duties will be the design of trunk sewers in connection with the Island Main Drainage Scheme and applicants should be competent to handle all phases of such work up to the tendering stage. Applicants should preferably be between 25 and 35 years of age and have passed sections A and B of the Institution of Civil Engineers examination or have some equivalent qualification.

(b) **TWO DRAUGHTSMEN** at a commencing salary within the range £400 to £500 a year. Applicants should be competent draughtsmen able to plot surveys and make finished drawings from dimensioned sketches. Ability to take levels and a knowledge of surveying would be an advantage. One appointment will be for general drawing office duties in connection with the design of new works, while in the case of the other the principal duties will involve taking measurements, plotting and making records of works.

The appointments will be temporary and terminable by one month's notice on either side.

Applications, stating age, whether married or single, giving full details of training, qualifications, present and previous appointments and accompanied by copies of two recent testimonials, must be delivered not later than 30th April, 1956, to the GREFFIER OF THE STATES, STATES' GREFFE, JERSEY, C.I.

The States of Jersey can undertake no responsibility for the provision of housing accommodation. K 920A

THE COLLEGE OF AERONAUTICS.

Applications are invited for the

PERRING SCHOLARSHIP IN AERONAUTICS, valued £400 per annum, tenable at The College of Aeronautics. The successful candidate will be admitted to the two-year course at the College.

Applicants should preferably be honours graduates or final year under graduates in engineering, mathematics or physics; applications from non-graduates with comparable qualifications will also be considered. Candidates must be British subjects domiciled in the United Kingdom.

Forms of Application and statement of conditions will be forwarded on written application to:

THE WARDEN,
THE COLLEGE OF AERONAUTICS,
CRANFIELD,
BLETCHLEY,
BUCKS.

The closing date for the receipt of applications is 18th May, 1956. K 997

ADMIRALTY.
ROYAL NAVAL SCIENTIFIC SERVICE.

DRAUGHTSMEN required in Admiralty Research and Development Establishments in London (Teddington area), Portsmouth, Weymouth, and Baldock (Herts) for the design of experimental apparatus needed for fundamental research or for fitting in H.M. ships. Experience is necessary in any of the following classes of equipment: light to medium electrical, electro-mechanical, precision mechanical and electronic.

Candidates must be British aged 21 years or over, with at least 3 years' practical workshop training and, preferably, with drawing office experience and/or possession of the O.N.C. or equivalent.

Appointments unestablished, but opportunities will occur to compete for established posts and for promotion.

Starting pay (London rate), £463 10s. per annum (aged 21), £635 (aged 28) rising by 4 increments to £725 per annum; slightly less in the Provinces.

Apply stating age, training, experience and qualifications to ADMIRALTY, SANCTUARY BUILDINGS (ROOM 151), GREAT SMITH STREET, LONDON, S.W.1. G 636

THE NIGERIAN RAILWAY CORPORATION invite applications for appointment as

ASSISTANT ENGINEER in the Civil Engineering Department to take charge of a sub-District or medium sized capital works. Applicants should preferably have had approved experience in Railway Engineering, including bridge, and general building construction, and possess initiative, sound judgment and strong physique. They should be Corporate Members of the Institution of Civil Engineers or possess an Engineering degree recognised as granting exemption from Sections I and II of the A.M.I.C.E. examination.

Appointment will be either on probation in a permanent post in the salary range £850-£1600 plus £300 overseas inducement pay per annum or on Contract in the same range plus a gratuity based on 20 per cent. of the total salary plus overseas pay payable at the end of each tour of satisfactory service, or on final completion of service. The point of entry will be dependent on age, qualifications and experience.

Terms of service provide for tours of fifteen months, free first class passages both ways for the selected candidate and his wife, annual maintenance allowance of £75 each in respect of a maximum of two children while in United Kingdom, or actual cost of their passages if under 18 years of age, part furnished quarters at low rental and the grant of leave at the rate of seven days per completed month of service. Outfit allowance of £60.

Applications should be addressed to the LONDON REPRESENTATIVE, NIGERIAN RAILWAY CORPORATION, 11, MANCHESTER SQUARE, LONDON, W.1, giving personal particulars, qualifications and experience. K 883

APPOINTMENTS OPEN.

THE ENGAGEMENT OF PERSONS answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

It is advisable when sending testimonials to forward copies and NOT originals.

WANTED

DRAUGHTSMEN to design in aluminium for sales development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to NORTHERN ALUMINIUM CO. LTD., BUSH HOUSE, ALDWYCH LONDON W.C.2. G 562

Leading manufacturers of container closures in the Midlands have a number of vacancies for ambitious **DESIGN DRAUGHTSMEN** preferably with some experience in this or a similar sphere. Interesting work with excellent salary and every opportunity for promotion to senior position in a rapidly growing organisation. Write in confidence with details of experience, positions held, salary required; to P. A. METAL CLOSURES LIMITED, BROMFORD LANE, WEST BROMWICH. G 627

STRUCTURAL ENGINEER with wide experience of the design and detailing of all types of steel structures and with administrative experience required to act as deputy to the Chief Engineer by large firm of London Consultants. The firm is expanding and the vacancy offers excellent opportunities for the right type of man.—Write in confidence giving details of previous experience and salary required to BOX No. 355, GLOVER'S ADVERTISING LTD., 351, OXFORD STREET, LONDON, W.1. G 635

ENGLISH ELECTRIC

STEAM TURBINE DESIGN ENGINEERS are required by English Electric, Rugby, for a rapidly expanding programme of Steam Turbine work, ranging from the smallest to the largest type of land turbines. The work is of a permanent nature and offers considerable scope to qualified engineers with some experience of turbine design problems.—Write in confidence, giving full details of previous experience, to DEPT. C.P.S., 336/7, STRAND, W.C.2 quoting Ref. 1200C. K 988

SERVO CONTROL DRAUGHTSMEN AND TRAINEES

required for the design of Industrial Electronic and Magnetic Amplifiers for Servo Mechanisms in connection with Electrical Motor Control Gear and associated equipment. Previous experience in this class of work preferred, but not essential. Experienced Draughtsmen on electrical and/or mechanical work are invited to apply.

Draughtsmen are also required for the preparation of wiring diagrams.

Trainees, of not less than S.2, O.N.C. standard or those who are now taking S.2 will be considered for all of the above. The positions are permanent and the work offers excellent opportunities.

Pension Scheme in operation.

Full canteen facilities.

Apply for application form, quoting reference "T.4," to:—

PERSONNEL MANAGER,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
TRAFFORD PARK, MANCHESTER, 17. K 862

DRAUGHTSMEN required for design and detail work on Mechanical Handling Plant for Gas Works, Power Stations, etc. Experience of this type of work comprising conveyors and associated structures etc. desirable but not essential. Good salaries will be paid to suitable applicants with profit sharing bonus and superannuation schemes. Applications in writing giving full particulars of age, experience and salary required to be forwarded to the CHIEF DRAUGHTSMAN, W. J. JENKINS & CO., LTD., 28, VICTORIA STREET, LONDON, S.W.1. L 95

BRITISH PETROLEUM COMPANY LIMITED has a vacancy for a

STATISTICIAN in the Physics Section at its Research Station at Sunbury-on-Thames. Applications are invited from men who have completed a degree course in Statistics or who have had equivalent experience. Work will be on statistical problems in the oil industry including statistical design of experimental programmes. Applicants should be capable of co-operating fully with Research Staff and of ensuring that statistical techniques are used to the best advantage. Knowledge of the oil industry is not an essential. Excellent working conditions. Non-contributory Pension Scheme and Luncheon Club facilities. Write giving full details, quoting H.3308, to BOX 8207 c/o 191, GRESHAM HOUSE, E.C.2. G 597

MECHANICAL ENGINEER to take charge of Workshop for services and development at Research Station. Served apprenticeship. Higher National Certificate in Mechanical Engineering or equivalent. Must be capable of original thinking. Location Surrey countryside. Pension scheme. Profit Sharing Scheme. Canteen.—BOX K 995, Offices of ENGINEERING.

POWER STATION SUPERINTENDENT

Required for modern industrial station with pass-out Turbo-Alternators providing steam and energy for a large continuous process plant, present capacity 7500 kW and process steam 100,000 lbs. per hour, shortly to be increased. Candidates should be Corporate Members of the Institution of Mechanical and/or Electrical Engineers, or possess equivalent qualifications and have had previous experience in a similar capacity including maintenance of Station. Operational experience with High Pressure (1000 lbs. per square inch) Boilers and Turbines in stations of similar, or larger, capacity an advantage. Very good salary with permanent and progressive position for first-class man who has the right experience and qualifications. Age 35-50. Pension Scheme, possible assistance with housing. Applications, which will be treated in confidence, should state age qualifications, experience and present remuneration and be addressed to PERSONNEL MANAGER, BRITISH ENKA LIMITED, AINTREE, LIVERPOOL, 9. L 172

ENGINEER to take charge of department applying Diesel Engines to Rail Traction. Experience of Diesel Engine operation essential also knowledge of railways and their requirements. Experience of electrical installation desirable.—Apply with details experience, age to PERSONNEL MANAGER, DAVEY, PAXMAN & CO., LTD., COLCHESTER. L 86

BRITISH PETROLEUM COMPANY LIMITED has vacancy for a

MECHANICAL ENGINEER (AUTOMOTIVE). Applicants should have an Engineering Degree or equivalent and preferably some experience in the Automobile and/or Petroleum Industry. A knowledge of spark ignition engine fuel and lubricating oil problems would be an advantage. Age limit 28 years. Successful candidates will be required to maintain technical contact with motor manufacturers and consumers in the U.K. and abroad. Salary according to age, qualifications and experience. Non-contributory Pension Scheme, Luncheon Club.—Write, giving full particulars, quoting H.3689, to BOX 8807 c/o 191, GRESHAM HOUSE, E.C.2. L 96

PUMPS AND TURBINES MAINTENANCE ENGINEER urgently required by Major Oil Company for service in MIDDLE EAST oilfields, age under 45 years. Applicants should be Mechanical Engineers of graduate standard and have had extensive experience in a supervisory capacity in operating, maintaining and installing all kinds of pumps and turbines. Previous oilfield experience desirable. Two year tour in first instance and salary not less than £2650 p.a. payable also while on leave. Married accommodation and free family passages available. Write, giving age, brief details of career, etc., and asking for application form to BOX EG.967, c/o 191, GRESHAM HOUSE, E.C.2. L 97

CONTRACT ENGINEER required. Experienced in Industrial Water Tube Boilers for steam and high and low pressure hot water, auxiliaries, instrumentation, and piping. Must be capable of taking charge of Contracts to completion. Good prospects for capable and keen man, with expanding company. Reply in confidence, giving fullest particulars, to THE SECRETARY, BOUELLAT ENGINEERING, LIMITED, 167-168, MILLBANK, LONDON, S.W.1. L 98

Vacancies exist in the Works Engineer's Department of a large Company in East London for

PERSONNEL CAPABLE OF DRAWING AND PLANNING LAYOUTS

for both Machine and Assembly Shops from information supplied by Time Study Departments, also experience in Ventilation and Extraction Systems, Palletisation and Mechanical Handling of Stores, etc. Age between 30 and 40. A salary of up to £750 will be paid to the selected candidates.—Please write, giving details of experience to BOX L 144, Offices of ENGINEERING.

DESIGNER DRAUGHTSMEN. SEVERAL JUNIOR AND SENIOR DRAUGHTSMEN required, with mechanical and structural experience, by a well-known firm manufacturing steelworks, coke oven and mechanical handling plant. Five-day week. Excellent office conditions. Staff Pension Scheme.—Write stating age, experience and salary required to—CHIEF DRAUGHTSMAN (C), THE WELLMAN SMITH OWEN ENGINEERING CORPORATION, LTD., DARLASTON, SOUTH STAFFS. L 94

MECHANICAL ENGINEERING DRAUGHTSMEN
and
CIVIL ENGINEERING DRAUGHTSMEN
IMPERIAL CHEMICAL INDUSTRIES LIMITED BILLINGHAM DIVISION

offer attractive salaries in respect of several vacancies for each of the above classes of draughtsmen. Candidates must possess as a minimum qualification, the appropriate Higher National Certificate or its equivalent. Participation in Staff Pension Fund and Profit-Sharing Scheme. Financial assistance towards removal expenses available for married men. Without commitment, write for Application Form to the STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, BILLINGHAM DIVISION, BILLINGHAM, CO. DURHAM, quoting reference U.12. G 633

Draughtsmen, Draughtswomen and Tracers — Mechanical Engineering.

For Engineering Consultants. Positions are permanent, pensionable, with five-day week. Free lunches. Basic Salary above A.E.S.D. minimum rates, plus profit sharing scheme.

Phone or write, giving details of previous experience, to the

PERSONNEL OFFICER, EWBANK & PARTNERS, LTD., 10/11, GROSVENOR PLACE, LONDON, S.W.1. 200 YARDS HYDE PARK CORNER. SLOANE 0486. G 630

Required:

AN ASSISTANT CHIEF ENGINEER with energy and mental agility to deal with Instruments, Pressure Vessels, Filtration, Chemistry and Metallurgy, Hydraulics and Light Engineering in general within a day's work. We require, therefore, a man of all-round proved ability, preferably certificated. Age to be 28-35. Salary according to capabilities. This position is offered with the rapidly expanding and pleasantly situated Company of SIMMONDS AEROCESSORIES, LTD., TREFOREST INDUSTRIAL ESTATE, PONTYPRIDD, GLAMORGAN, and applicants should write, in confidence, to the PERSONNEL MANAGER. L 88

SENIOR DRAUGHTSMAN required, London area. Heavy Mechanical Engineering experience essential, knowledge of gearing an advantage.—Write stating age and salary required and giving full details of experience to The SECRETARY, THE POWER PLANT COMPANY LIMITED, WEST DRAYTON, MIDDLESEX. L 89

A WORK STUDY ENGINEER is required by a progressive firm of Manufacturing Chemists in the West London area. Applicant should preferably have an engineering degree or equivalent and training in work measurement and method study techniques. Opportunities exist for investigation into a wide range of activities and practical experience in work study is essential. Five-day week, pension and profit participation schemes. Salary according to age and experience.—Write giving full details of qualifications, experience and age to BOX L 91, Offices of ENGINEERING.

Applications are invited for the following positions in the RICHARDSONS WESTGARTH GROUP:—

CHIEF PRODUCTION ENGINEER (functioning in co-operation with Works Manager) for land and marine steam and gas turbines, large marine diesel engines, condensing plants and auxiliaries, at the Group's four Works, all of which are on the North-East Coast. Applicants must have had a wide and thorough experience of production planning and progressing in heavy engineering of the above or similar character, and must be fully conversant with the best modern practice.

CHIEF MECHANICAL ENGINEER for Richardsons Westgarth (Hartlepool) Ltd., to supervise technical departments dealing with design and operation of large and small steam turbines, gas turbines, condensing plants and feed heating systems for land and marine use; blowers, compressors, etc.

YOUNG TECHNICAL ENGINEERS of degree or H.N.C. standard for interesting work in the fields of design of turbines (steam and gas), heat exchangers and condensers, and testing and servicing large power station equipment.

Good terms of remuneration; pension scheme.

Applications should be sent to the Group's Head Office, addressed to:—
THE MANAGING DIRECTOR,
RICHARDSONS, WESTGARTH & CO., LTD.
(P.O. BOX No. 2),
WALLSEND, NORTHUMBERLAND,
and marked "Appointments; Strictly Confidential." They will not be disclosed without consent. L 54

ESSO DEVELOPMENT COMPANY has a vacancy for an

ENGINEER to advise on the application of Petroleum Products in the Aviation Industry. Applicants for this post should have had a minimum of ten years diversified experience in the Aviation Industry, part of which at least should have been with an engine builder. The situation, which is permanent and pensionable, requires a man of British Nationality who has a flair for dealing with people and is prepared to travel. The salary will depend on the age and qualifications of the successful applicant, but will take full cognisance of the responsibility undertaken. In the first instance candidates should write, giving brief personal details, to the MANAGER, ESSO EUROPEAN LABORATORIES, ESSO HOUSE, ABINGDON, BERKS. L 189

ENGINEERS.

Applications are invited from qualified

MECHANICAL ENGINEERS (preferably A.M.I.Mech.E.) for a number of permanent and pensionable appointments at Fort Dunlop. Industrial experience of plant layout and mechanical handling systems is desirable: knowledge of Work Study techniques an advantage. These positions provide excellent scope for advancement in an expanding Company with world-wide interests. Please write, giving age, qualifications, experience and salary required, to the PERSONNEL MANAGER, DUNLOP RUBBER CO., LTD., FORT DUNLOP, ERDINGTON, BIRMINGHAM, 24. L 190

DESIGNER DRAUGHTSMAN required in London for the preparation of schemes and estimates for comprehensive materials handling installations. Must have had design experience in bulk handling equipment for Power Stations, Steelworks, Gas Works, etc., and only those having this experience will be considered. The position is a permanent one and the commencing salary will be of the order of £1000 per annum. A contributory pension scheme is in operation. Applicants should give the fullest details in first instance, and replies should be addressed to BOX L 191, Offices of ENGINEERING.

UNITED GAS INDUSTRIES LIMITED require for their Subsidiary Company, Dowson & Mason, Limited, Levenshulme, Manchester, manufacturers of fuel-fired furnaces of various types, an **ASSISTANT GENERAL MANAGER**, who, in addition to being competent to deal with all stages of furnace construction from the preliminary enquiry through the various stages of design, fabrication, erection and test, should be an experienced administrator. The company also manufactures space heaters, burners, smokehouse equipment, tanks and storage and dispensing equipment for petrol and oil. A commencing salary of £1750 per annum is envisaged which in this expanding business would allow for future growth. Applications with fullest details should be addressed in confidence to THE CHAIRMAN, UNITED GAS INDUSTRIES, LIMITED, 51, LINCOLN'S INN FIELDS, LONDON, W.C.2. L 193

EXPERIENCED ENGINEER wanted as Methods Engineer for medium-sized Brake Lining Manufacturers. Promotion to Assistant Works Manager in approx. two years if suitable. Knowledge of jig and tool design essential. Age preferably 30-40. Commencing Salary £800 to £900 per annum dependent on qualifications. Staff Pension Scheme. Apply giving full details of qualifications and experience, to PERSONNEL OFFICER, BRAKE LININGS LIMITED, BUXTON, DERBYSHIRE. L 205

A CIVIL ENGINEER, with evidence of recognised eminence in profession, seeks responsible high-salaried appointment, preferably centred London; highest academic qualifications, research record, appreciative critiques of his published work and lectures; experienced home and abroad as Consultant and Government Service; lengthy high-level control of design and construction, contract and direct labour, for Harbour and River Works, Coast Protection, opening and fixed Bridges, Structures generally, Waterworks, Sewerage, Oil Facilities; also control of an A.R.P. Organization during War; all covered by responsible testimonials, and personal references available prominent men London and elsewhere.—BOX 1536, EASON'S ADVERTISING SERVICE, DUBLIN. L 194

DRAUGHTSMEN. First-class Structural Draughtsmen required at top rates. Five-day week, pension fund, permanent position with good prospects. Apply in writing giving full particulars, to STAFF OFFICER, B.I.C.C. CO., LTD., 30, LEICESTER SQUARE, LONDON, W.C.2. quoting reference C/2/55. L 198

ENGINEERS.

(NEWCASTLE UPON TYNE).

Any skilled man holding an Ord. Nat. Cert. in Mech. Engineering and experienced in Jig and Tool Work is invited to apply for vacancies arising for Trainee Jig and Tool Draughtsmen.

Openings are also available for men to design special purpose Boring and Milling Machines.

Attractive salaries and permanency for good men. Overtime available. Pension Scheme.—Write BOX L 199, Offices of ENGINEERING.

DESIGNERS AND DRAUGHTSMEN.

Expanding Drawing Office (Newcastle) requires Design Draughtsmen for Jig and Tool Work, and for the design of special purpose Boring and Milling Machines.

Salaries in accordance with educational standard and experience. Permanent positions in long-established concern for suitable applicants. Pension and Welfare facilities available.

Please give age, education, experience, etc.—Write L 200, Offices of ENGINEERING.

INDIAN STEELWORKS CONSTRUCTION COMPANY, LTD.

This consortium of British Engineering Firms formed to supply and erect the Durgapur Steel Works in West Bengal, India, invites applications for the following key posts in India:—

1. PROJECT MANAGER (INDIA) to take charge of general administration of the whole project in India. Detailed Steel Works knowledge is not essential, but would be advantageous. Experience in administration of large scale Contract work is required.

2. RESIDENT CHIEF ENGINEER. Steel Works experience necessary and preferably actual experience in construction on Steel Works Development Schemes.

Appropriately high salaries will be paid to suitable applicants with suitable arrangements for families and passages. Contract 4-5 years.

Replies to:—
INDIAN STEELWORKS CONSTRUCTION COMPANY, LTD.,
19, VICTORIA STREET,
LONDON, S.W.1. L 203

JOHN LAING AND SON LIMITED

invite applications for the following technical staff vacancies :—

STRUCTURAL DESIGN ENGINEERS, preferably qualified, with sufficient design experience to undertake work on their own responsibility.

STRUCTURAL DESIGNER/DETAILERS AND DRAUGHTSMEN with good design office experience.

The appointments are mainly at Head Office, and a wide field of interesting work is covered—particularly suitable for those studying for a qualification. The posts are permanent and pensionable. Five-day week. Staff canteen. Sports Club facilities. Please apply in writing stating age, qualifications and experience to :—PERSONNEL MANAGER (S.D.2), JOHN LAING & SON, LIMITED, BUILDING AND CIVIL ENGINEERING CONTRACTORS, PAGE STREET, LONDON, N.W.7. L 73

SITE AGENTS.

Required for Building and Civil Engineering contracts in various parts of the country. Applicants will be expected to have sound supervisory experience on a wide variety of contract work. Professional qualifications are required for those seeking senior Civil Engineering appointments. Full mobility essential. Age 30-50. Salary commensurate with experience and qualifications.

The Company has an established policy of employment security and men who prove themselves can expect advancement and permanent pensioned employment.

Applications in writing to:
PERSONNEL MANAGER (SA.4), JOHN LAING & SON LIMITED,
BUILDING AND CIVIL ENGINEERING CONTRACTORS,
LONDON, N.W.7. L 27

INDUSTRIAL CONTROL GEAR ENGINEERING

The Industrial Control Department (Servo Section) of Metropolitan-Vickers Electrical Co., Ltd., is expanding and has vacancies for

GRADUATE ELECTRICAL ENGINEERS

with experience of magnetic and electronic amplifiers. A good technical knowledge of the theory of closed loop control systems is necessary and some background on conventional (open loop) industrial control gear practice would be an advantage.

The work involves design and application of closed loop control for a wide variety of industrial motor drives, e.g., for Steelworks, Mine Winders, Paper-making Machinery and Machine Tools, etc.

The posts are permanent and pensionable.

Apply for Application Form, quoting reference " Y.4," to :—

Personnel Manager,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
Trafford Park, Manchester 17. L 45

RESEARCH ASSISTANT to join small gearing research team, H.N.C. or Degree in Mech. Eng., gearing experience desirable but not essential. Attractive salary commensurate with qualifications and experience.—Apply to LABOUR MANAGER, VICKERS-ARMSTRONGS (ENGINEERS), LTD., BARROW-IN-FURNESS, LANCS. L 195

DRAUGHTSMEN.

Vacancies for

SENIOR AND JUNIOR, preferably with marine background, experience in pipe arrangements for diesel installations an advantage; Good conditions; pension scheme; five day week and excellent prospects open to suitable applicants; Apply giving details and qualifications to the CHIEF DRAUGHTSMAN, NORTH EASTERN MARINE ENGINEERING CO., LTD., WALLSEND-ON-TYNE. L 204

DRAUGHTSMEN (SENIOR AND JUNIOR) required for work in connection with the following branches of Coke Oven and Gasworks plants.

(*a*) Mechanical and By-Product Plant.
(*b*) Pipework.
(*c*) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week; Canteen Facilities.—State age and experience to the PERSONNEL OFFICER (D.O.), WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD., WOODALL-DUCKHAM HOUSE, 63-77, BROMPTON ROAD, LONDON, S.W.3. G 550

QUALIFIED ELECTRICAL ENGINEER required for work in London. Must possess comprehensive knowledge of electrical installation work in all types of buildings and be fully conversant with the recognised wiring systems and all regulations governing this type of work. Knowledge of building construction and ability to read architects drawings essential. Able to prepare electrical specifications and illumination schemes. Five-day week. Pension Fund. Reply to BOX L 206, Offices of ENGINEERING, giving details of age and experience and quoting reference L/8/55.

J. MOWLEM & CO., LTD. have vacancies in their Concrete Laboratory for a

CONCRETE ENGINEER and an **ASSISTANT CONCRETE ENGINEER.** These vacancies are permanent and form an excellent opportunity for the right type of man. Salary according to age and experience. For the junior position previous experience in this type of work is not essential as adequate training will be given.—Apply, giving all details in own handwriting to BOX L 20, Offices of ENGINEERING.

DRAUGHTSMAN, MECHANICAL, required for work on heavy mechanical engineering and pulverised fuel equipment. Experience this class of work would be useful. Voluntary superannuation scheme available working week five days. Please reply, quoting experience. Salary approx. £800.—BOX L 41, Offices of ENGINEERING.

ENGINEERING DRAUGHTSMAN required immediately for large developments at Iron and Steel Works in the Midlands. Accustomed to taking responsibility, and preferably with technical training up to N.C. or H.N.C. standard. Should have a sound experience in general engineering.—Apply to BOX L 50, Offices of ENGINEERING.

Classified Advertisements continued on Page 8

ROLLS-ROYCE
AERO ENGINE DIVISION.
(Scottish Factories.)

ROLLS-ROYCE LIMITED have established a Gas Turbine Design and Development Division in a new factory at East Kilbride, situated approximately eight miles from Glasgow.

Vacancies exist for the following categories:

DEVELOPMENT AND TECHNICAL SERVICE ENGINEERS.

For development work on engines, fuel systems, and accessories to improve performance and extend engine life. Applicants should be of degree standard preferably with some experience of this type of work or have had considerable experience of development work in this field.

DESIGN DRAUGHTSMEN.

Applicants should have minimum technical qualifications of H.N.C. (Mechanical or Production Engineering) and some design experience.

DETAIL DRAUGHTSMEN.

Applicants should have previous drawing experience in light mechanical engineering, specialised training on aero gas turbine work will be provided where necessary.

Housing accommodation in the new town of East Kilbride will be supplied if required after a three months probationary period.

Application forms are available from the PERSONNEL MANAGER, ROLLS-ROYCE LIMITED, HILLINGTON, GLASGOW, S.W.2, and envelopes should be marked TE/25. K 980

DESIGNER-DRAUGHTSMAN required, experienced in water-tube boilers for steam generation and/or high pressure hot water heating. Work covers the design of pressure parts, structures and casings, etc., and boiler house layouts. Good prospects with expanding company.—BOUELLAT ENGINEERING LIMITED, 167, MILLBANK, S.W.1. L 72

ENGINEER required at new Works at Loughton, Essex, to develop mechanical processes associated with handling, counting, tabulating and destroying Bank Notes in bulk.

Candidates, who must be British by birth, must have a sound engineering background with experience in design of light mechanisms and must be able to supervise development contracts. A knowledge of accounting machinery, computers or character recognition systems would be of advantage.

Starting salary up to £1100 per annum is envisaged but special consideration will be given to candidates of particularly appropriate experience. Permanent pensionable employment; financial assistance with housing available.—Apply in writing, stating full details of age, education, qualifications and experience to the STAFF MANAGER, ST. LUKE'S PRINTING WORKS (BANK OF ENGLAND), OLD STREET, LONDON, E.C.1. K 984

SECTION LEADER DRAUGHTSMAN required to take charge of the drawing office in the newly-created SMALL MOTORS DIVISION, BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH. Applicants should be familiar with the mechanical design of A.C. and D.C. machines and should preferably have some experience of small control panels. This post offers first-class opportunities for promotion and a good salary to a man able to work with the minimum of supervision. Conditions of service include non-contributory superannuation.—Please apply to the CHIEF PERSONNEL OFFICER. K 991

ENGINEERING DRAUGHTSMEN are required immediately for General Developments at Iron and Steel Works. People accustomed to taking responsibility are required preferably with technical training up to H.N.C. or degree standard, who should have sound experience in General Engineering. Good salaries will be paid to the right people. Apply to BOX L 51, Offices of ENGINEERING.

ACROW

require

STRUCTURAL ENGINEER

(QUALIFIED)

for position of

GENERAL MANAGER

of new Division about to be formed

Must have not only a broad knowledge of

GENERAL STRUCTURES & BRIDGES

but also wide experience in

SELLING

such structures

Applicants must be prepared to travel abroad

Applications, stating age and experience, will be treated confidentially by the Managing Director,

ACROW (ENGINEERS) LTD.
South Wharf, Paddington, London. W.2.

K 879

WILTON ICI WORKS

ENGINEERING DESIGNERS

The construction of the Company's factory at Wilton on a 2000-acre site has proceeded continuously since 1946 and now over ten million pounds are spent each year on new works. Staff with experience in design of modern works are required for this development.

The immediate vacancies are in the Design Office for :—

ASSISTANT TECHNICAL OFFICERS
MECHANICAL ELECTRICAL
CIVIL STRUCTURAL
INSTRUMENT

The appointments are to permanent staff and the Company is anxious to engage men who have had first rate experience to assist with the long-term plans for further development. Candidates in this category will be invited to interview, without commitment, at the Company's expense.

SALARIES
Commencing salaries up to £900 per annum will depend on the age and experience of candidates. The salaries of men engaged will be reviewed annually.

TERMS OF EMPLOYMENT
Five-day, 39-hour working week, Pension Fund, Profit Sharing Scheme, etc.

HOUSING
After joining the staff married men will receive a reasonable refund of removal (including travel) expenses, and to assist them in house purchase, facilities are available in approved cases for substantial loans; in addition, legal charges will be advanced.

Assistance is given in the procuring of rented houses, flats or lodgings.

Wilton is situated at the foot of the Cleveland Hills in Yorkshire, five miles from the coast. Working conditions are good and recreation facilities, including golf, tennis and badminton, are available.

Write for application form to: Staff Manager, Imperial Chemical Industries Limited, Wilton Works, Middlesbrough, Yorkshire, quoting advertisement reference ICI/X/293/e. L 10

BRITISH CELLOPHANE LIMITED, BRIDGWATER, SOMERSET,

seeks **SENIOR AND JUNIOR DRAUGHTSMEN,** for both PERMANENT and TEMPORARY appointments, for work on machine design and chemical plant layout. Applicants should possess at least O.N.C. and have had three years' shop experience. Five-day week, Pensions Fund scheme for permanent appointments. Ref. No. E.48.Eg.

The TEMPORARY appointments are for a period of approximately two years' duration, subject to three months' notice and include generous subsistence allowances, and periodic home return rail fares.

ESTIMATOR (PERMANENT).—Applicants should have served an engineering apprenticeship and have technical education up to O.N.C. standard. The work involved will be on the preparation of material and labour specifications in connection with engineering work, electrical estimating experience an advantage. Ref. No. E.49.Eg.

ASSISTANT ENGINEER, age 23/30 (permanent).—Applicants should have an honours degree in mechanical engineering and have had some practical works experience. The duties will be on development, improvement and maintenance of chemical and other plant. Ref. No. E.50.Eg.

ASSISTANT ENGINEER, age 25/50 (permanent).—Applicants should have a university degree and have works experience, or be an A.M.I.Mech.E. The duties will be on development, improvement and maintenance of plastic films extrusion plant and ancillary equipment. Ref. No. R.45.Eg.

Write to the PERSONNEL OFFICER, stating full particulars and salary required, and quote Ref. Nos. as indicated. L 32

GRADUATE MECHANICAL ENGINEERS

who are keen to join a RESEARCH GROUP engaged in the study, design and development of hydraulic control valves, pumps, miniature high-speed turbines and auxiliary power systems are invited to apply for SENIOR and JUNIOR posts with the GUIDED WEAPONS DIVISION OF THE ENGLISH ELECTRIC CO., LTD., AT LUTON, BEDS.

These positions give scope for original work in Thermodynamics, Hydraulics and Servo mechanisms, and attractive salaries are offered to the right men. Housing assistance may be possible in certain instances.—Apply in strict confidence to DEPT. C.P.S., 336/7, STRAND, W.C.2, quoting Ref. 1000K. L 71

DEPUTY RESIDENT ENGINEER.

OLYMPIA LIMITED, invite applications for this appointment from engineers who have served a regular apprenticeship and who preferably hold a recognised engineering qualification. The person appointed will be responsible under the Resident Engineer for the installation, operation and maintenance of all electrical and mechanical plant and services and the supervision and control of the engineering staff engaged thereon. Staff Pension Scheme and good salary for the right man. The successful applicant for the appointment as advertised will be considered for promotion to the senior position (Resident Engineer), within the near future. Applicants should be aged between 30-40 years and are asked to apply in writing giving full details of education, training and experience to THE ESTATES MANAGER, OLYMPIA LIMITED, KENSINGTON, W.14. L 102

VICKERS-ARMSTRONGS
(Aircraft) LIMITED

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED,
WEYBRIDGE, SURREY,

require:

(*l*) **DRAUGHTSMEN (SENIOR, INTERMEDIATE AND JUNIOR)** for the design of electrical and radio systems, instruments, structures, power plants, installations, mechanism, furnishing, etc. Aircraft experience not essential.

(*m*) **FLIGHT TEST INSTRUMENT TECHNICIANS** for the making, calibrating and servicing of prototype aircraft test instrument installations.

(*n*) **AIRCRAFT SPARES SCHEDULE COMPILERS**—suitable ex-R.A.F. personnel required or civilians with airframe maintenance experience.

(*o*) **INSPECTORS** for assemblies, tinsmiths, details and other branches of aircraft production.

The Company will be interested also in considering applications from other experienced Technicians and Tradesmen in occupations applicable to the Aircraft Industry.

Applications, quoting date and prefix letter of advertisement to:

EMPLOYMENT MANAGER,
VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED,
WEYBRIDGE WORKS, WEYBRIDGE, SURREY. L 18

WORK STANDARDS

BRIGGS MOTOR BODIES, LTD., require an Engineer to take charge of large Work Standards and Method Improvement department. Applicants must have had experience in Time Study and allied problems with a large engineering concern. Position is a senior one. Salary, pension and other benefits will be commensurate with such position.

Applicant should write with full personal details to MR. J. A. BARKE, GENERAL MANAGER, BRIGGS MOTOR BODIES, LTD., DAGENHAM, ESSEX, under personal and confidential cover, for interview. L 197

ENGINEER required with good academic qualifications and research or industrial laboratory experience to carry out the work of establishing and running a Hydraulic Research Laboratory for model tests of pumps and water turbines.

SENIOR ELECTRICAL DRAUGHTSMAN for the mechanical design and detail of electrical rotating machines.

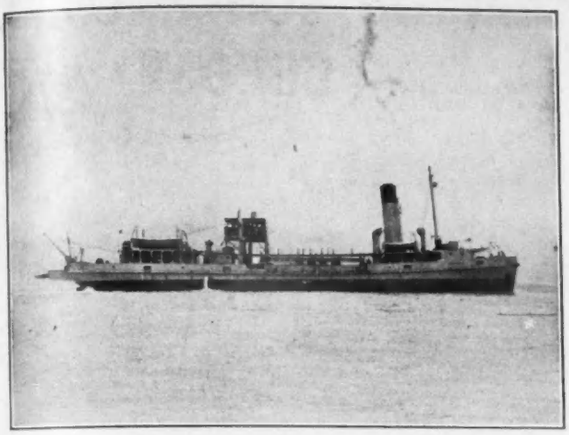
SENIOR DRAUGHTSMAN for the design and detail of Hydraulic Pumps.

SENIOR DRAUGHTSMAN for design and detail of water turbines.

SENIOR DRAUGHTSMAN for an interesting development of Atomic Power Auxiliaries. The work will be novel requiring initiative and a sound basis of technical qualifications and experience. An attractive salary will be offered to the right man.

QUALIFIED ELECTRICAL AND MECHANICAL ENGINEERS are required to undertake preparation of specifications and tenders for composite schemes comprising electrically, steam and diesel driven pumping machinery for waterworks, mining, industrial and power stations. Applications must be of H.N.C. standard or above, preferably with experience of similar work. Good salary according to previous experience. Superannuation scheme for permanent staff.—Applications in writing to PERSONNEL MANAGER, THE HARLAND ENGINEERING CO., LTD., ALLOA, SCOTLAND, giving full particulars of age, education and experience. L 116

Classified Advertisements continued on Page 118



TWIN SCREW SUCTION HOPPER DREDGER "MANDOVI"
[constructed for the
WEST OF INDIA PORTUGUESE GUARANTEED RAILWAY CO. LTD.
Dimensions: 175 ft. × 32 ft. × 13 ft. 6 ins. moulded.
Hopper capacity: 500 tons Speed Loaded: 9 knots.

DREDGING PLANT

TO THE LARGEST DIMENSIONS AND CAPABILITIES

PATENT CUTTER SUCTION DREDGERS, PATENT DIPPER DREDGERS, BUCKET HOPPER DREDGERS, SUCTION HOPPER DREDGERS, HOPPER BARGES, PIPE LINES FLOATING CRANES, etc.

NEW BUCKETS, LINKS, PINS, GEARING, etc., supplied for existing Dredgers.

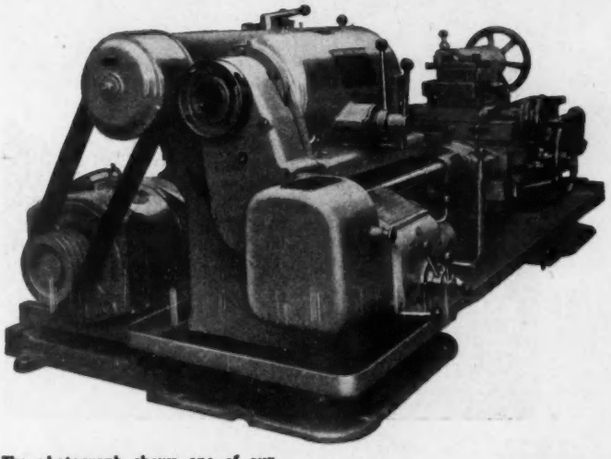
FLEMING & FERGUSON, Ltd.

SHIPBUILDERS & ENGINEERS, PAISLEY, SCOTLAND.
'Phone: Paisley 4121 *Teleg. Address: "Phenix."*
London Agents: Messrs. Nye & Marks, Ltd., Capel House, 42, New Broad Street, London, E.C.2
Telephone: LONDON WALL 4848

We are designers and manufacturers of a full range of high-class Power Transmission Appliances

V-BELT DRIVES

The choice of the Machine Tool Industry



The photograph shows one of our drives mounted on a Denham Model SSB heavy duty centre lathe.

R. HUNT & CO. LTD.

ATLAS WORKS · EARLS COLNE · ESSEX
Telephone: Earls Colne 202

". . . nothing but the BEST is good enough . . ."

MESSRS. ROLLS-ROYCE LTD. specified 'DELTA' alloys (Brass and Bronze) for use in their "DERWENT" engine units for the record breaking jet-propelled 'GLOSTER METEOR' aircraft

for best results specify always:

'DELTA' NON-FERROUS METALS AND ALLOYS

THE DELTA METAL COMPANY LTD. LONDON AND BIRMINGHAM

C

FASTER ASSEMBLY

WITH...

HELI-COIL*

SCREW THREAD INSERTS

* REGD. TRADE MARK

No fractional gains either; substantially faster and surer assembly is a certainty and here's why:—

Fit Heli-Coil! and reduce number of fastenings required. Use set bolts (which can now be shorter) instead of double threaded studs and eliminate "worrying" cover plates, etc., into position.

Fit Heli-Coil! and reduce torque loading for same duty. Reduce the wall boss size—no counterbore needed. Use lighter materials and improve thread strength. *Fit Heli-Coil!* and have all the advantages of a polished, rolled, internal thread.

Please write for full information.

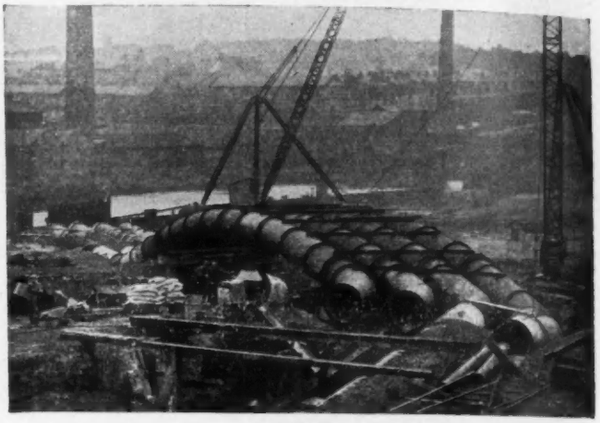
ARMSTRONG PATENTS CO., LTD.

BEVERLEY, YORKSHIRE.

CLAYTON SON & CO. LTD.

TELEGRAMS: "WELDERS, LEEDS" **LEEDS.** TELEPHONE: 75277-8

London Office: Thorncliffe, Oakfield Road, Ashtead, Surrey

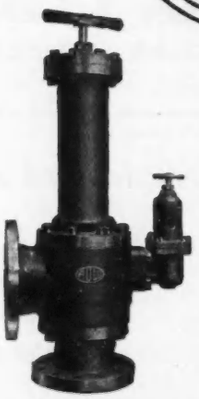


Reproduced by Permission of British Electricity Authority, Yorkshire Division.

54 In. DIA MILD STEEL CIRCULATING WATER PIPES, SPANNING THE CALDER & HEBBLE CANAL AT THORNHILL GENERATING STATION.

WELDED STEEL MAINS — A SPECIALITY —

AULD



Patent Full Bore Safety Valve

FIT AULD'S PATENT REDUCING VALVES for all duties on Steam, Air or Water Services

AULD'S PATENT Full Bore Safety Valve enables full area of seat to be utilised for discharge.

Class "A" Reducing Valve

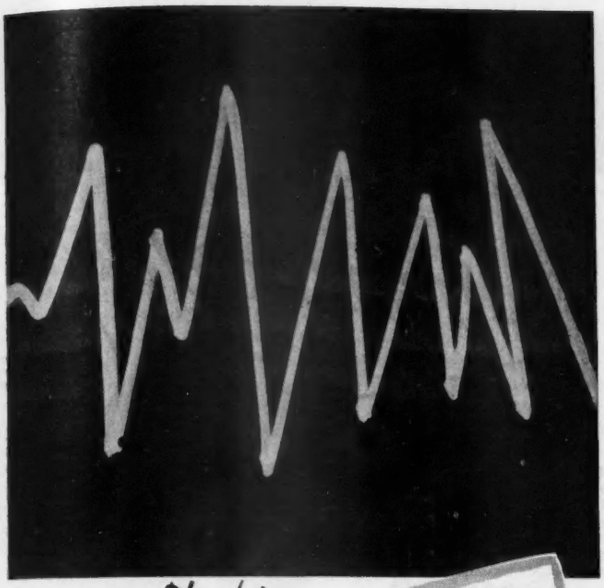
We also manufacture

SURPLUS VALVES, COMBINED SURPLUS AND REDUCING VALVES, STOP VALVES, STEAM TRAPS, DE-SUPERHEATERS, COMBINED REDUCING AND DE-SUPERHEATING UNITS

DAVID AULD & SONS LTD.

Whitevale Foundry, GLASGOW.

Telephone No. Bridgeton 1262 Telegrams: "Reducing," Glasgow



INDUSTRY IS *Shocking*

If you could calculate the loss of efficiency caused by vibration you wouldn't wait to write to Coopers, you would wire. When you realise that the Croid-Cooper method of machine installation also enables you to change layouts overnight—well, where's that telegraph form? We should also welcome your enquiry by telephone or letter.

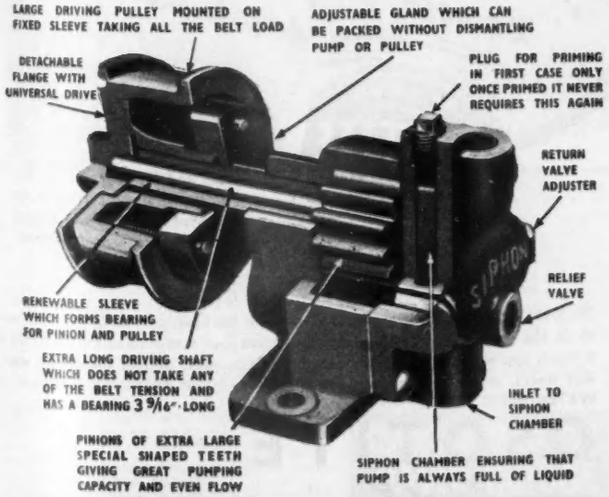
CROID 65
MACHINE FIXING GLUE
COOPERS
FELT

COOPER & CO. (B'ham) Ltd., Brynmawr, Breconshire

Tel.: Brynmawr 312. 'Grams: Felting Brynmawr.

WE ARE DESIGNERS AND MANUFACTURERS OF THE

MODERN *Siphon pump*


LARGE DRIVING PULLEY MOUNTED ON FIXED SLEEVE TAKING ALL THE BELT LOAD
ADJUSTABLE GLAND WHICH CAN BE PACKED WITHOUT DISMANTLING PUMP OR PULLEY
DETACHABLE FLANGE WITH UNIVERSAL DRIVE
PLUG FOR PRIMING IN FIRST CASE ONLY ONCE PRIMED IT NEVER REQUIRES THIS AGAIN
RETURN VALVE ADJUSTER
RELIEF VALVE
RENEWABLE SLEEVE WHICH FORMS BEARING FOR PINION AND PULLEY
EXTRA LONG DRIVING SHAFT WHICH DOES NOT TAKE ANY OF THE BELT TENSION AND HAS A BEARING 3 9/16" LONG
INLET TO SIPHON CHAMBER
PINIONS OF EXTRA LARGE SPECIAL SHAPED TEETH GIVING GREAT PUMPING CAPACITY AND EVEN FLOW
SIPHON CHAMBER ENSURING THAT PUMP IS ALWAYS FULL OF LIQUID
SIPHON

MODERN
MACHINE TOOLS LIMITED

Broadgate House · Coventry · Phone 2132/6

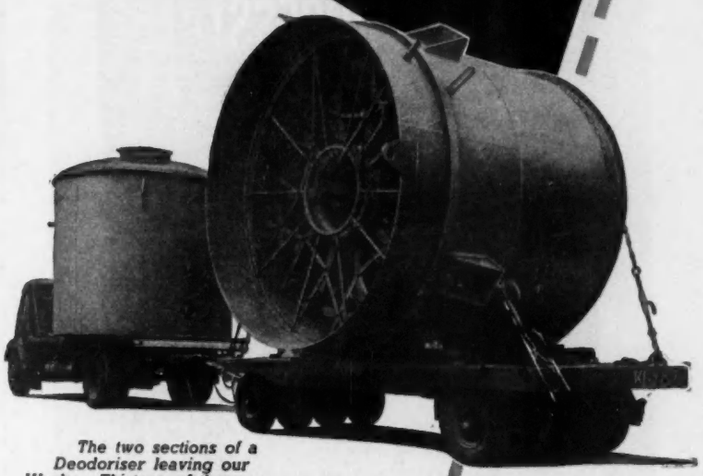
Sheffield: Corporation St. Phone 24988

Showrooms: Gosford St. Coventry

Rainbow

ENGINEERS TO THE CHEMICAL AND ALLIED INDUSTRIES

also specialists in the production of welded fabrications, riveted work etc.



The two sections of a Deodoriser leaving our Works. Thirteen of these units have been supplied, installed and site welded at a new Refinery.

Example of a Riveted Acid Storage Tank. 9' 0" dia. x 24' 0" long. 10,000 Galls. capacity.

We invite your enquiries for supplies involving the use of . . .

STORAGE TANKS PANS CONDENSERS WASHERS
PRESSURE VESSELS STILLS HEAT EXCHANGERS
GAS MAINS JACKETED VESSELS COLUMNS
AUTOCLAVES PIPE & VALVE WORK MIXERS
SILOS KEIRS EXPANSION JOINTS

RILEYS
OF BATLEY

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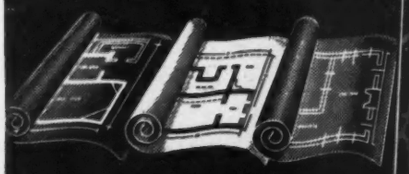

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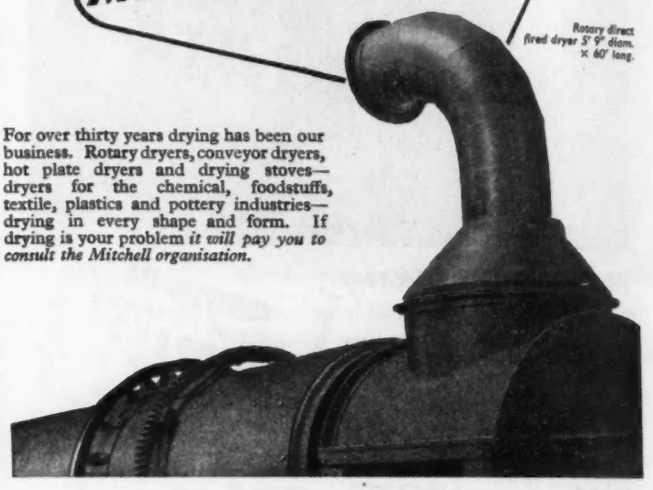

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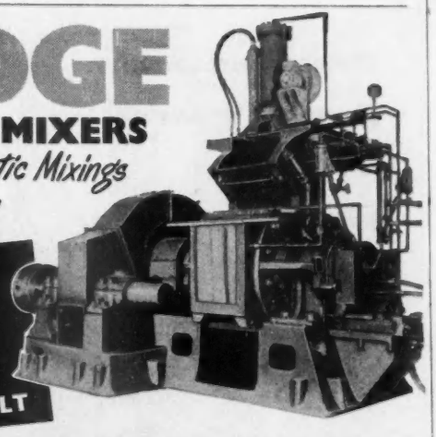

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Size of Machine	Net Volume of Chamber		Approx. Batch Size in lb. Spec. Gravity x Factor*	Motor H.p.	Motor Speed	Length	Floor Length	Space Width	Width
	cu. in.	c.c.			r.p.m.	ft. in.	mm.	ft. in.	mm.
B	103	1,690	Sp. G. x 2·5	7½	710	5 0	1,524	4 0	1,218
00	263	4,310	Sp. G. x 4	10	485	8 0	2,436	4 0	1,218
1	1,140	18,700	Sp. G. x 24	40	485	13 6	4,114	7 6	2,286
3A	4,562	74,750	Sp. G. x 100	100	485	15 0	4,572	8 0	2,436
9	11,443	187,500	Sp. G. x 225	200	485	33 0	10,100	9 6	2,895
11	15,469	253,500	Sp. G. x 300	250	485	27 0	8,228	11 0	3,352

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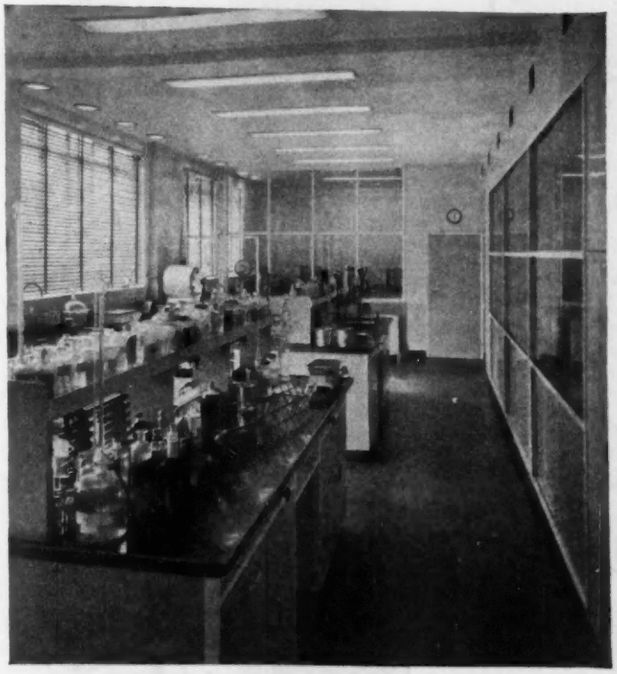

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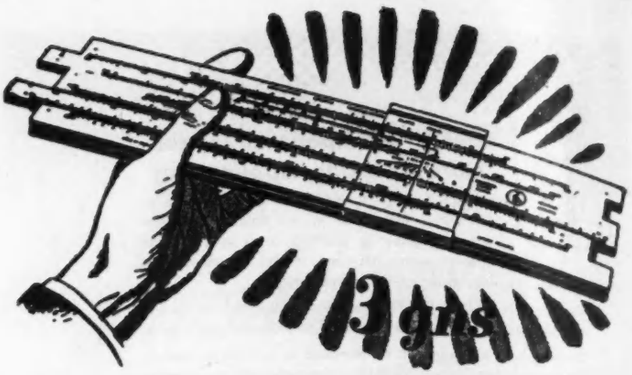

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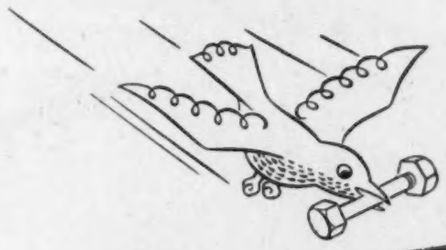
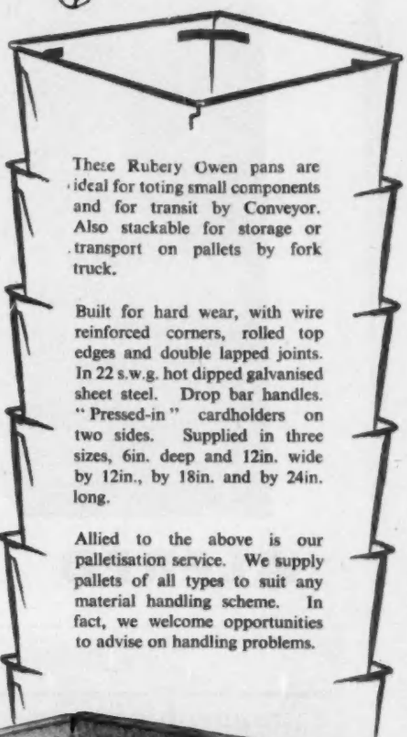


A nest of 'totes'



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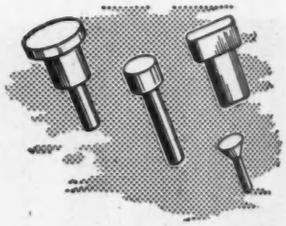

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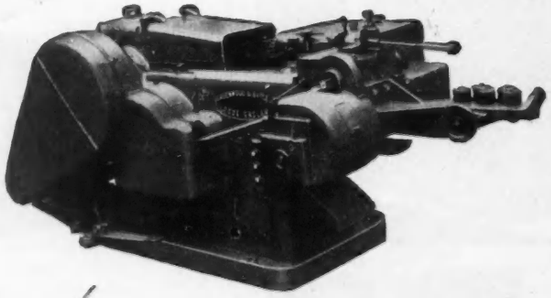
greater economy in material and cost with . . . . .



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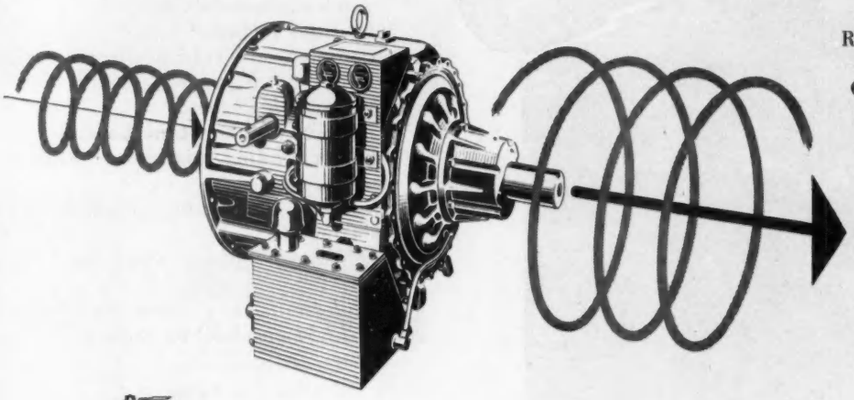
For diesel power units in the 60 to 600 b.h.p. range . . .

ROLLS-ROYCE

TORQUE CONVERTERS



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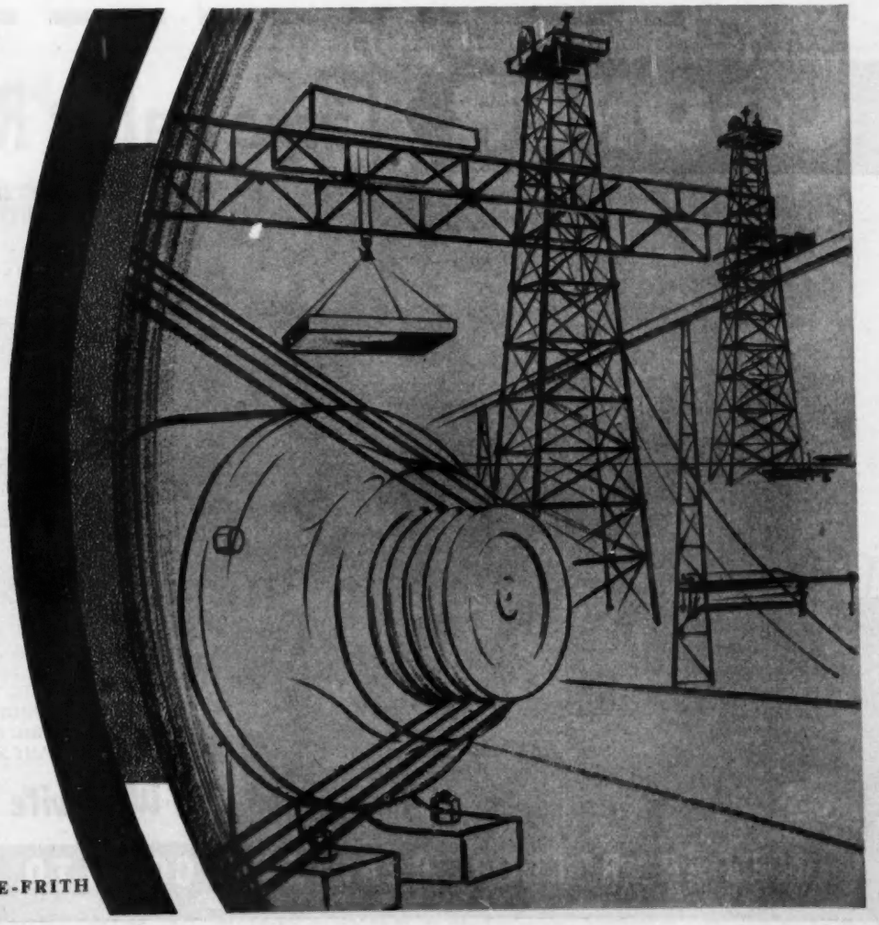
When industry gets tough Ferodo can take it



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FERODO
Friction Linings for Industry

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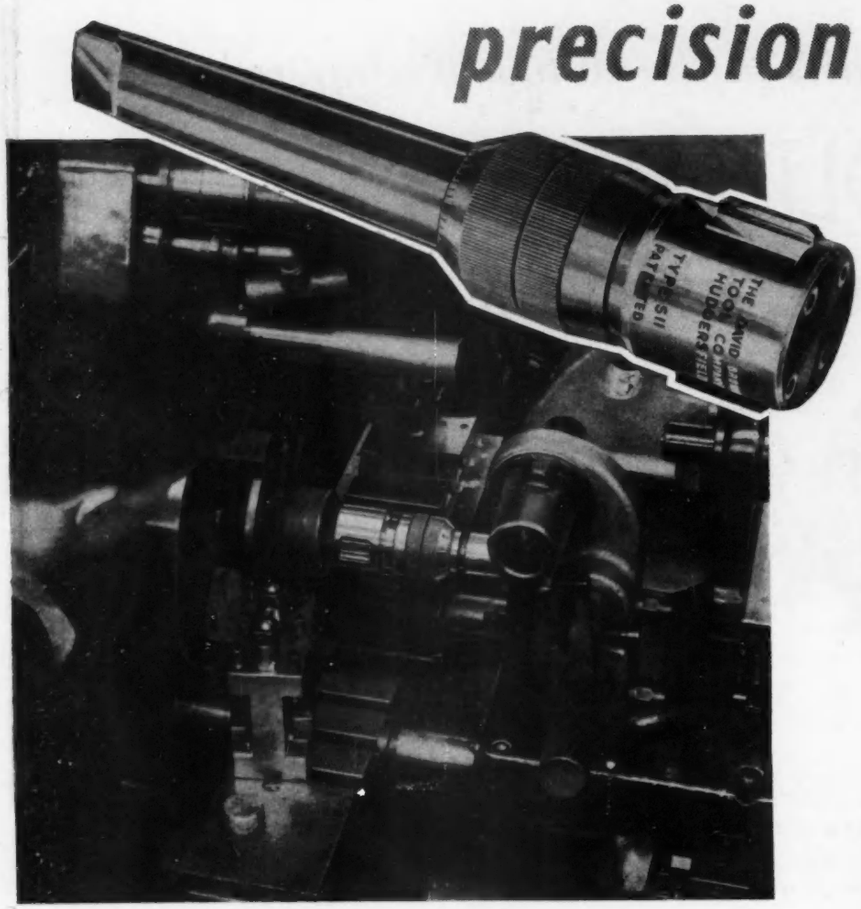

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Taper to 16° apex angle
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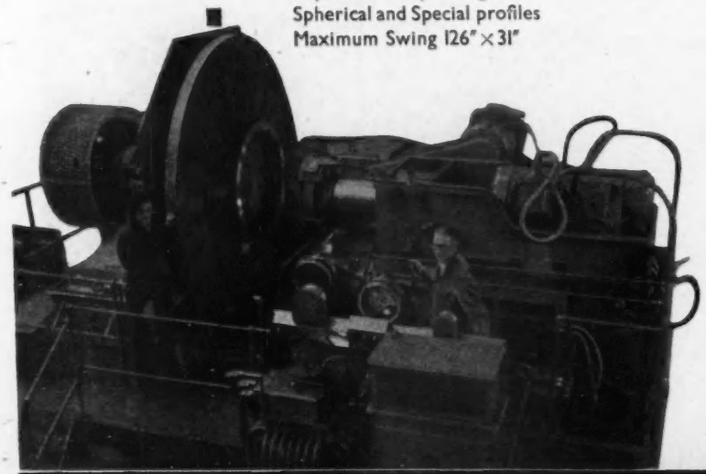

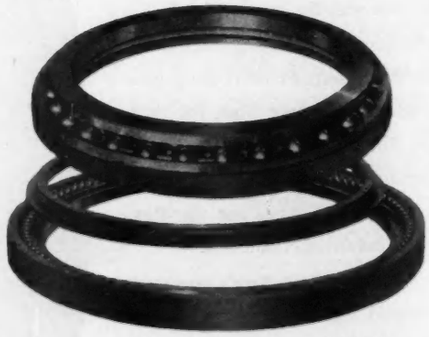

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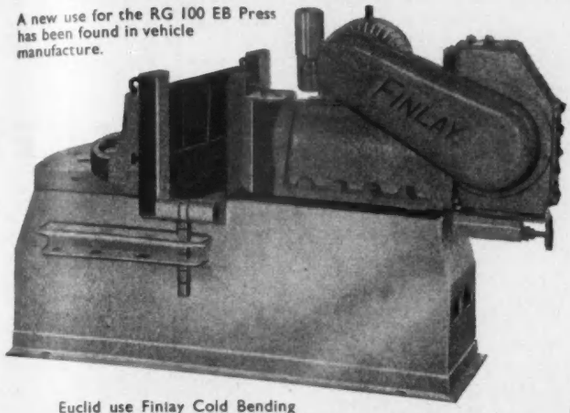
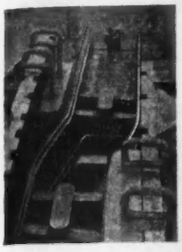
Economy, adaptability in COLD BENDING

A new use for the RG 100 EB Press has been found in vehicle manufacture.

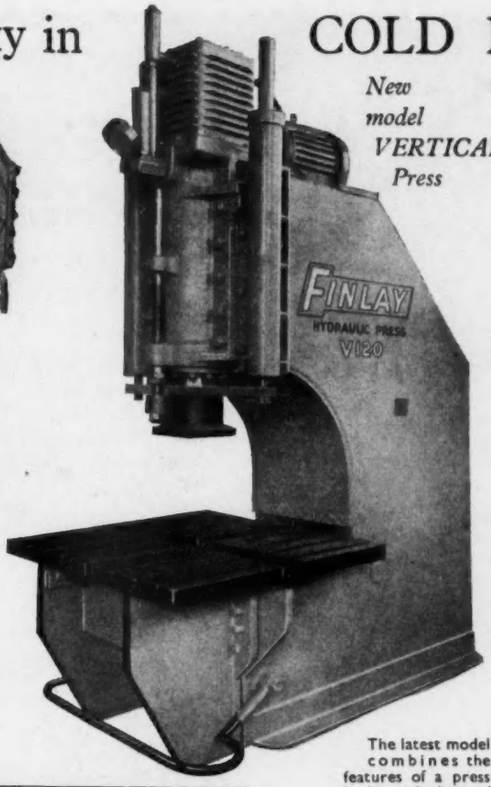


Euclid use Finlay Cold Bending machines to shape the two main chassis members of their F.D.T. tractor.



The finished members cold bent to shape in two minutes.

New model VERTICAL Press



The latest model combines the features of a press brake with those of the usual type of table press.

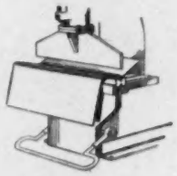
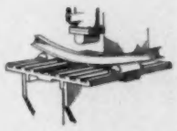
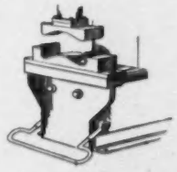


Plate bending up to 48" w'de by ½" thick



Section Forming using straight faced blocks.



Component Fabrication —a wide range of steel pressings can be formed.

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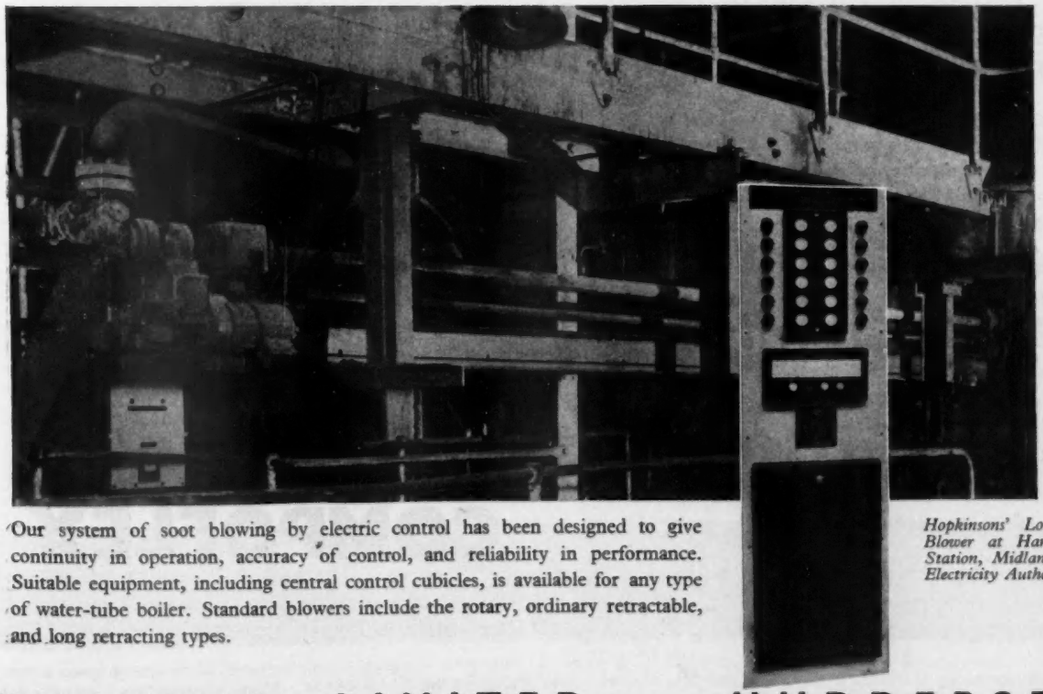
HOPKINSONS' SOOT BLOWERS

with Automatic Sequence Control



Our system of soot blowing by electric control has been designed to give continuity in operation, accuracy of control, and reliability in performance. Suitable equipment, including central control cubicles, is available for any type of water-tube boiler. Standard blowers include the rotary, ordinary retractable, and long retracting types.

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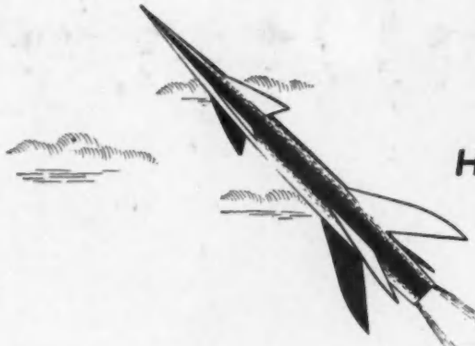
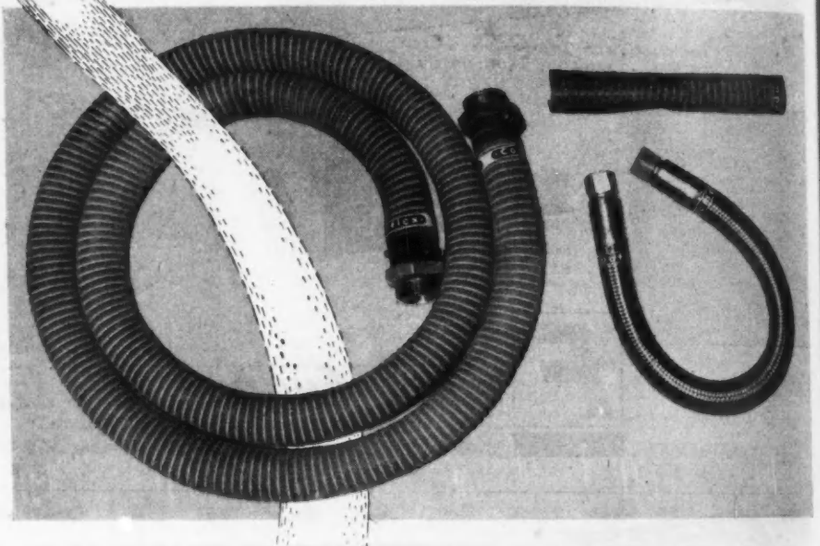


How many problems in a **ROCKET?**



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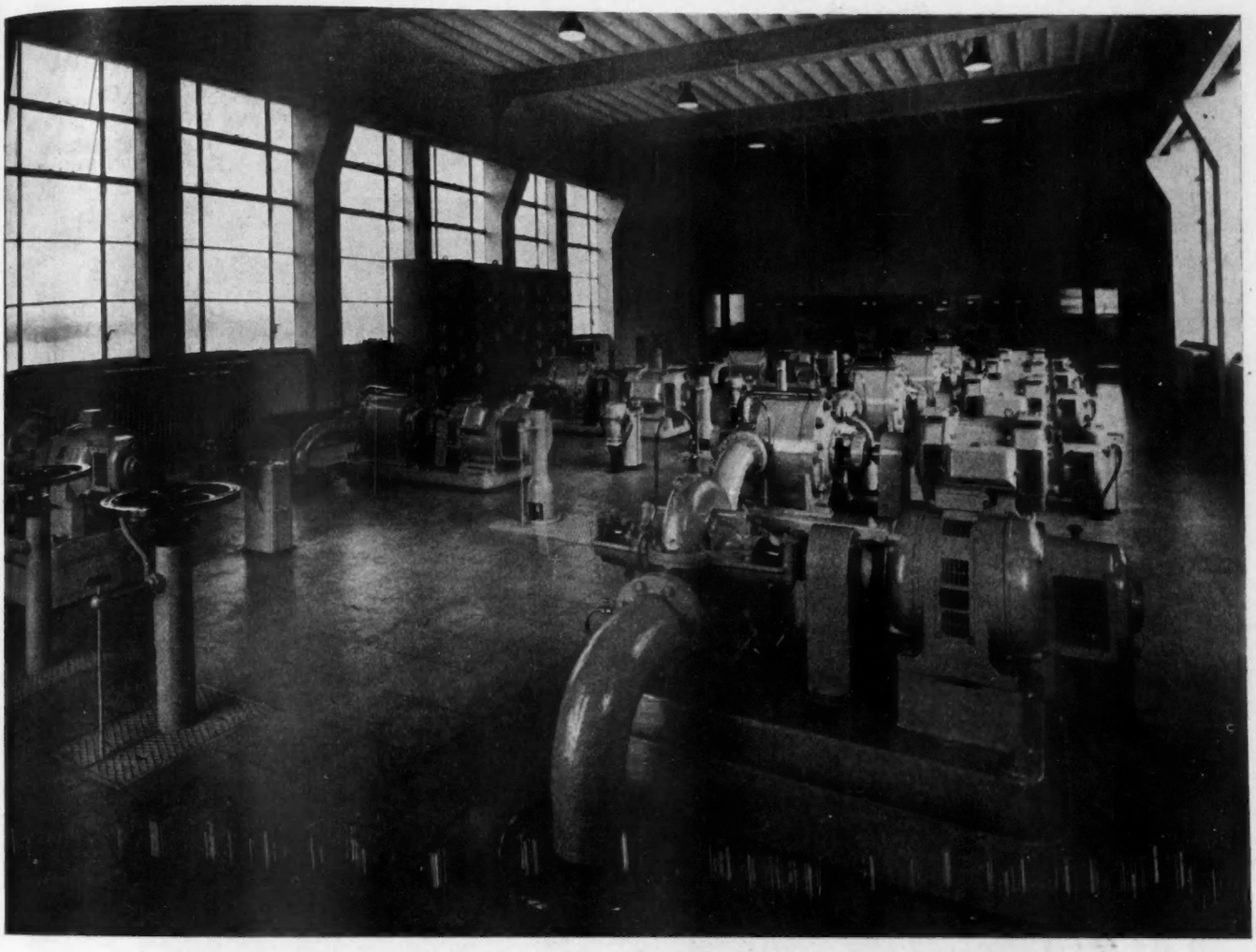

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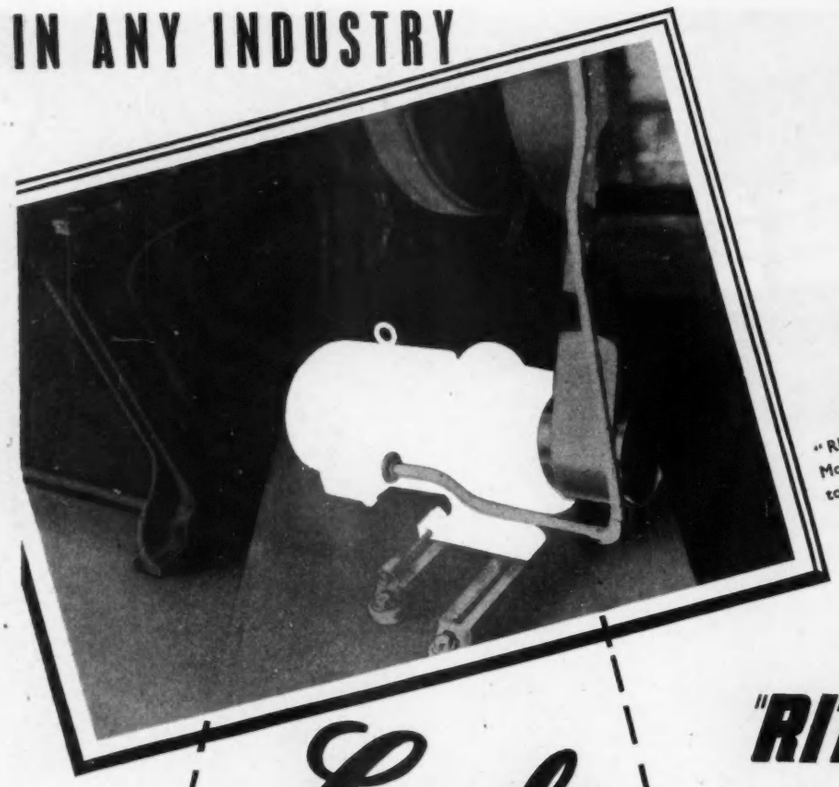

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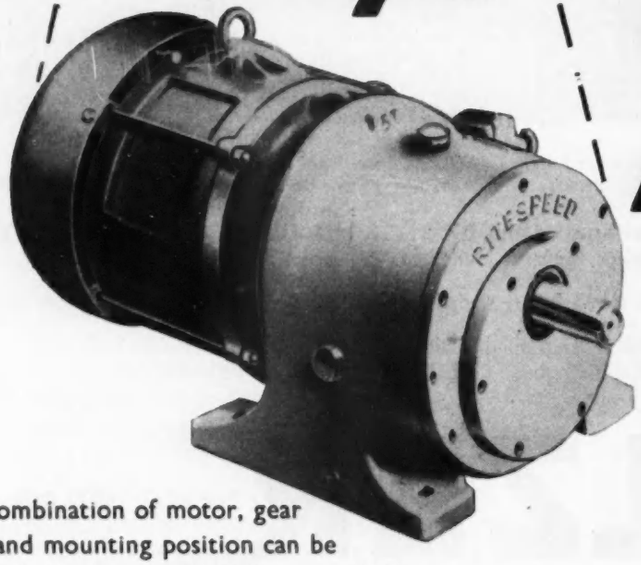

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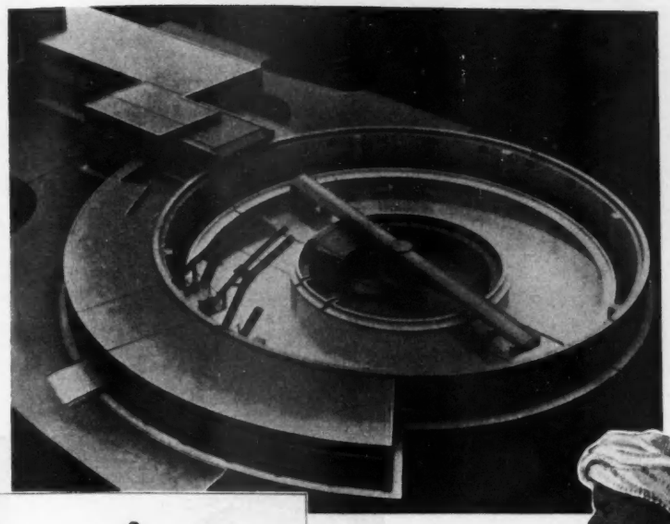

BUSHEY PARK
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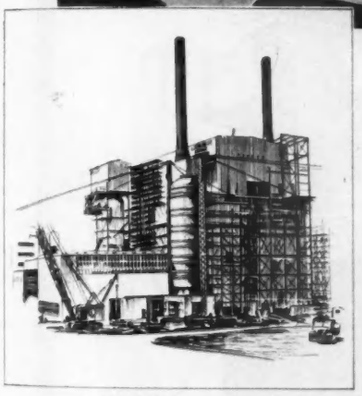

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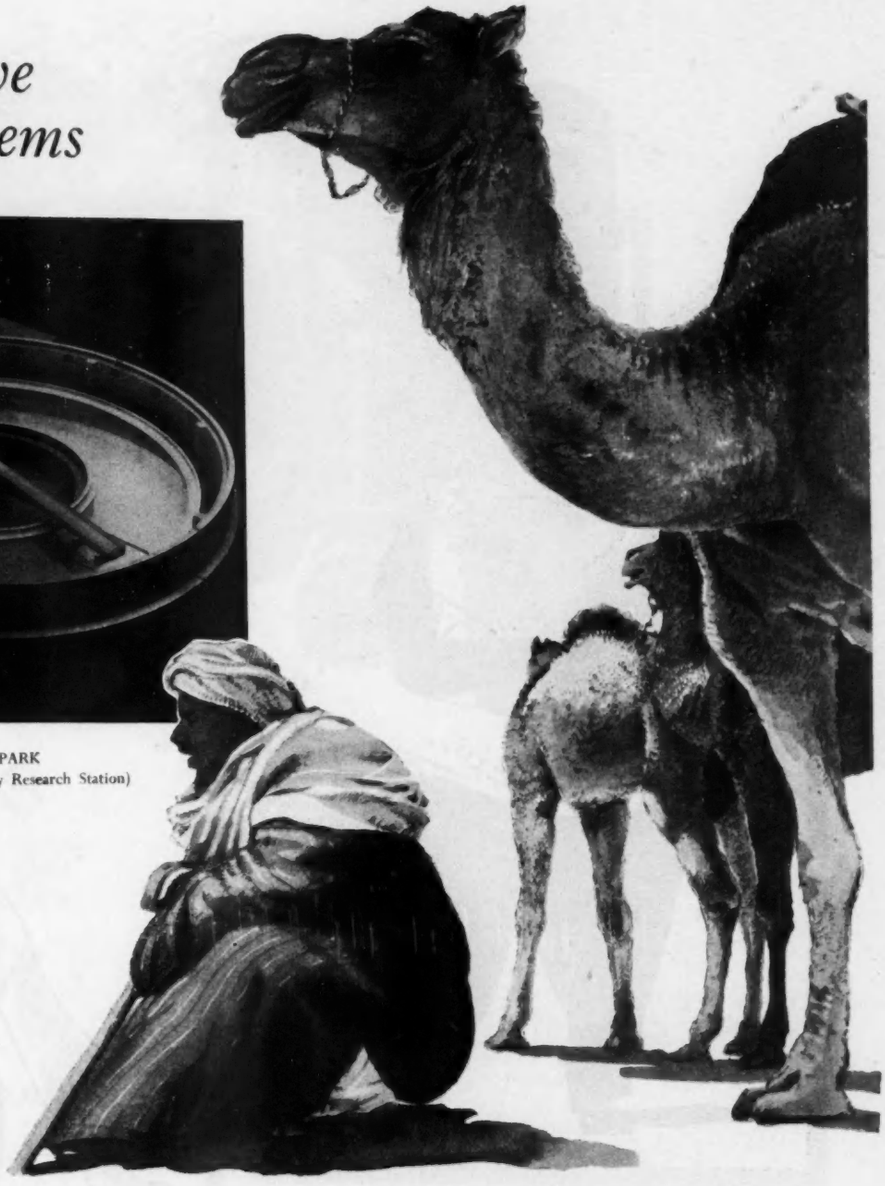

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Very fond of a grouse is Fred. Doesn't have to look far either. 'Like the perishin' North Pole in this perishin' factory', growls Fred. But at least he stays on the job; half the girls are away with the sniffles.

Now meet Bert — of the boiler'ouse

'It's no good them coming grousing to me,' glowers Bert, 'radiators are full on (or nearly), and the Guvnor's always bitin' my 'ead off about the fuel bills.'

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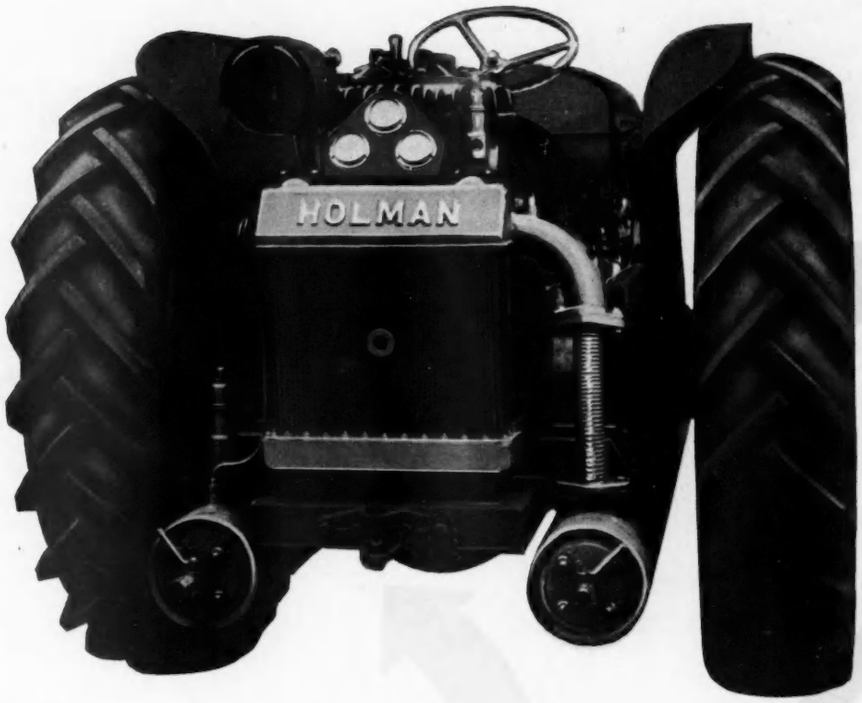

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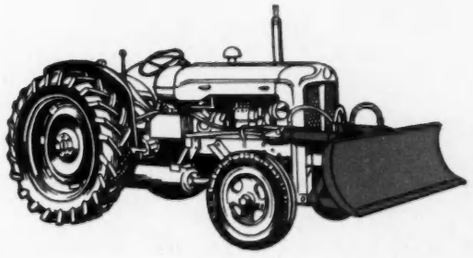

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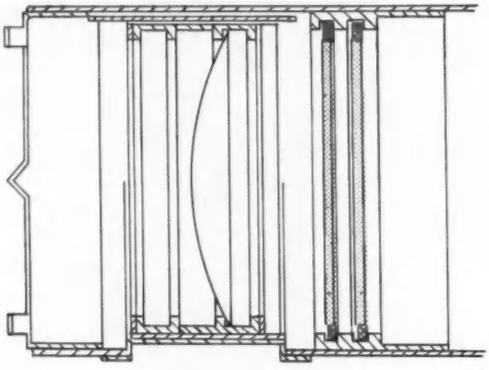

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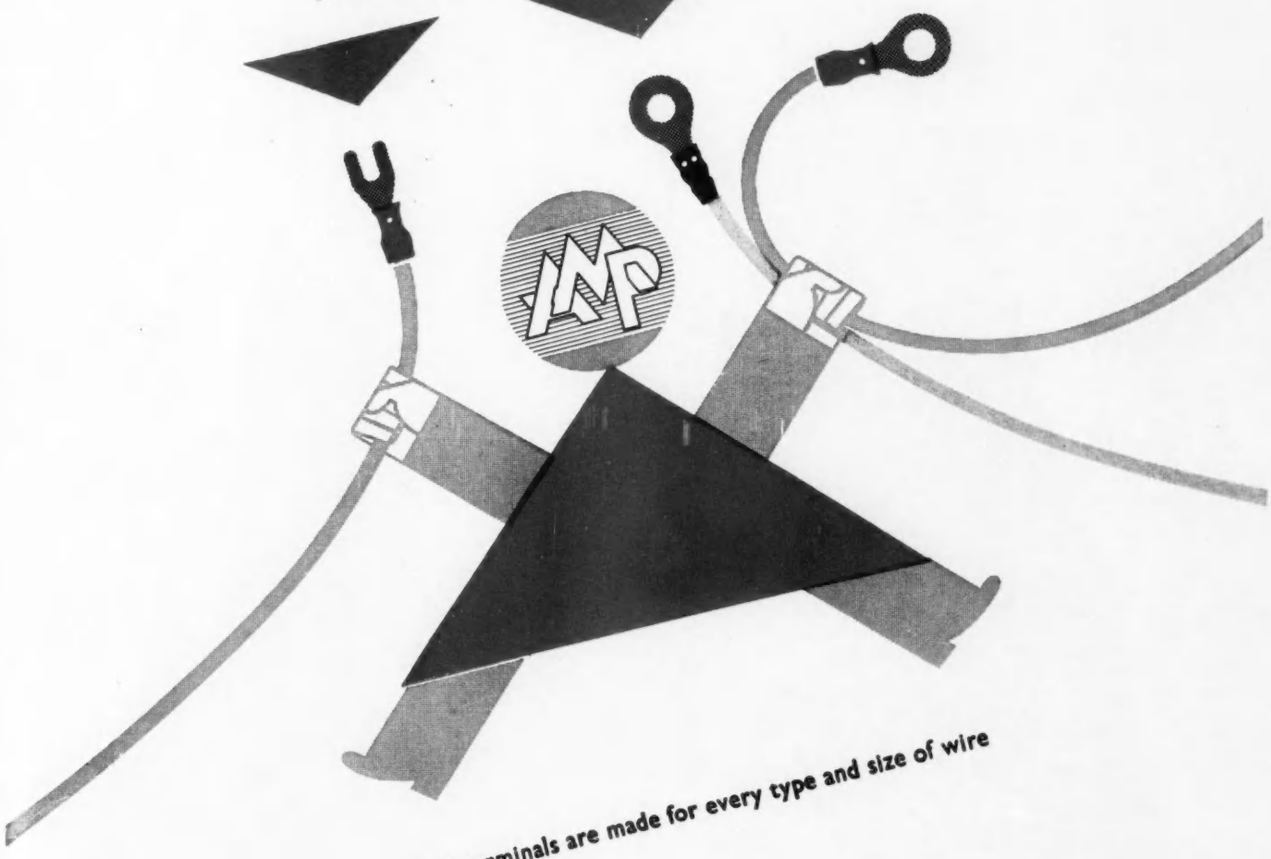

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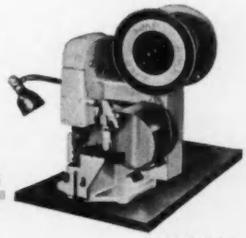

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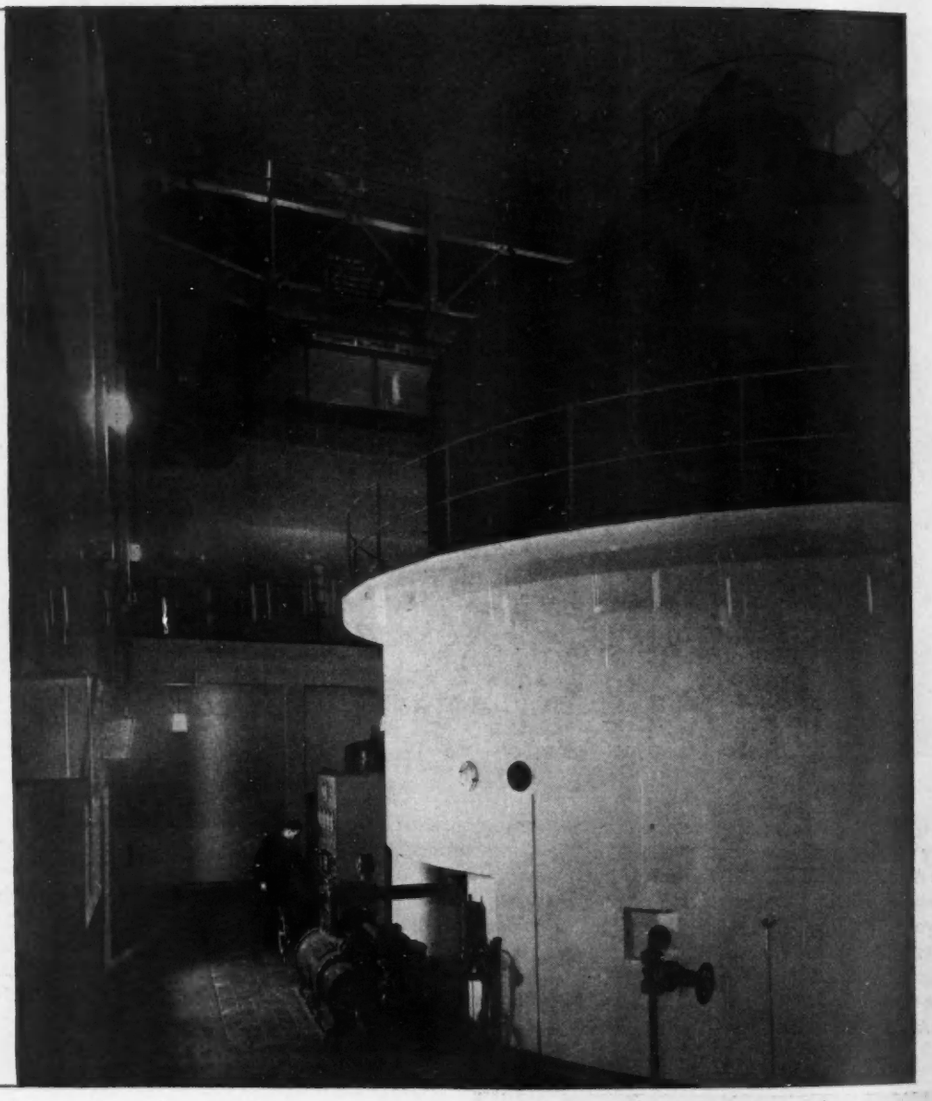

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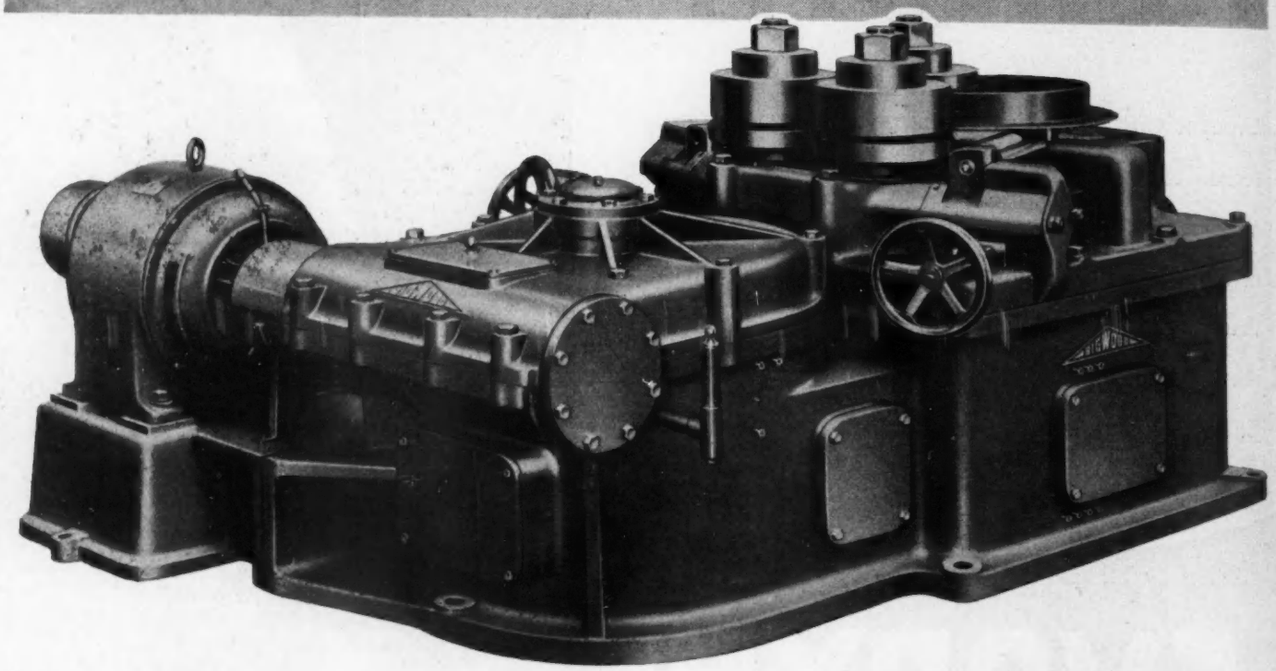

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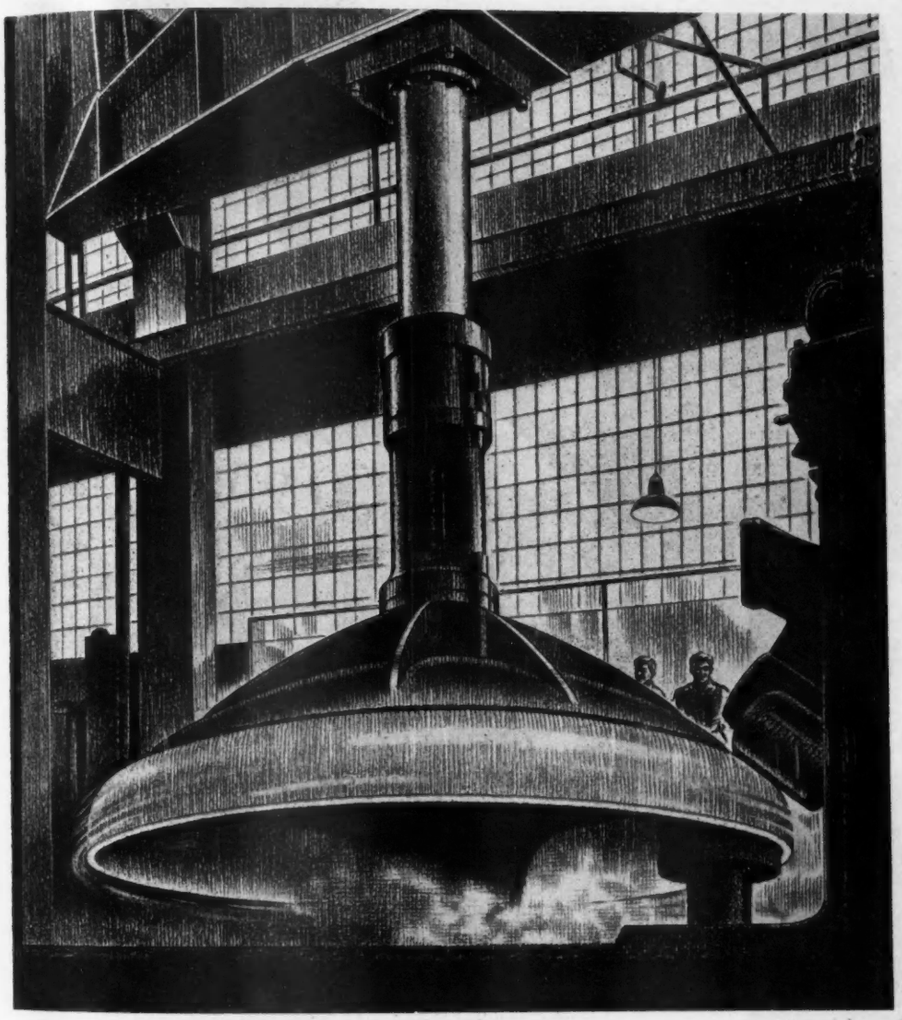

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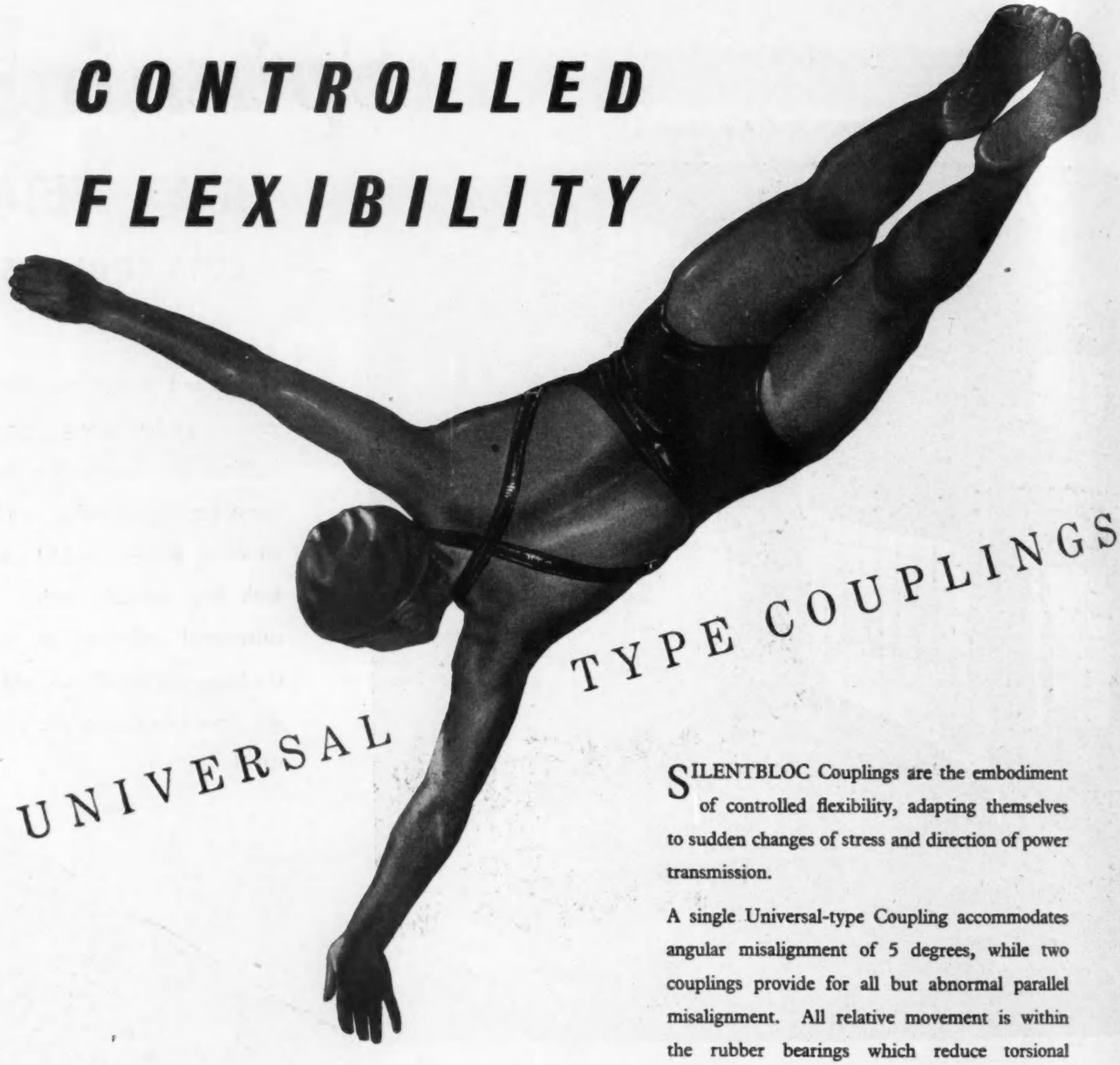

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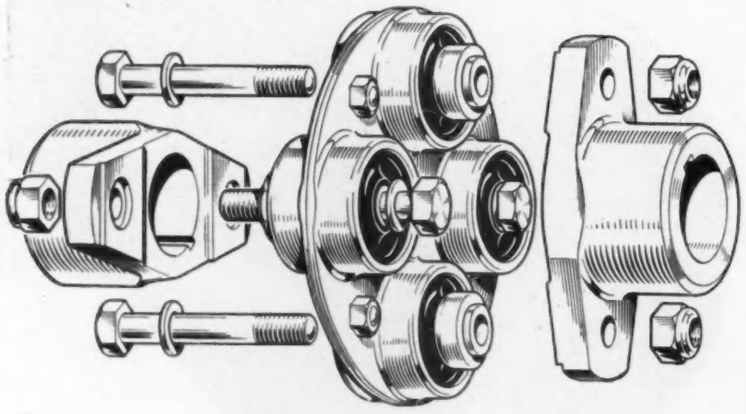
SILENTBLOC Couplings are the embodiment of controlled flexibility, adapting themselves to sudden changes of stress and direction of power transmission.

A single Universal-type Coupling accommodates angular misalignment of 5 degrees, while two couplings provide for all but abnormal parallel misalignment. All relative movement is within the rubber bearings which reduce torsional vibration and absorb shock loads. The Universal Coupling needs no lubrication, no maintenance and no protection from water, grit or dirt. Sizes to transmit from 0.15 to 20 h.p. at 100 r.p.m. are available.



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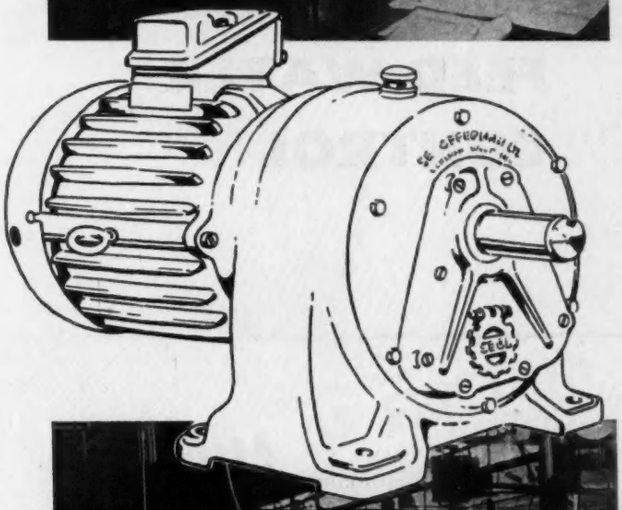

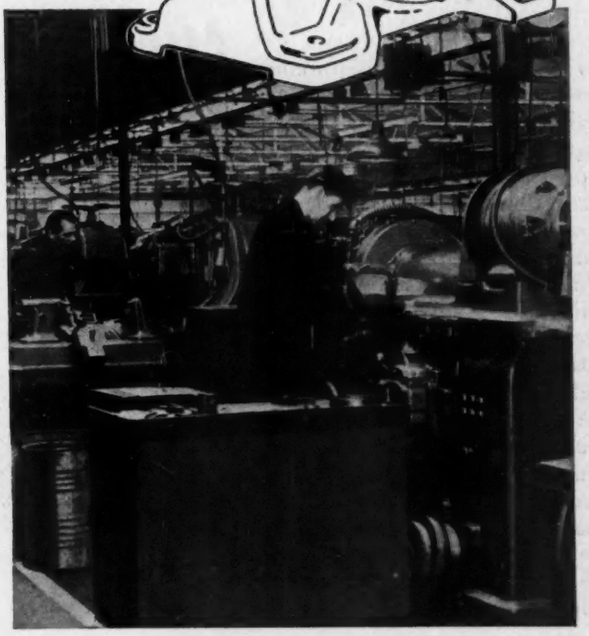

Carrying out the production, in all phases, of such varied engineering projects as components for jet engines, radar for ships and aircraft, complete turbo blowers, rear axles for taxicabs, reduction gears, gear boxes, geared motor units, even Band I and Band III television units and aerials, the extensive resources of S. E. Opperman Ltd. can and do most economically serve some of Britain's greatest industrial undertakings and some of the smallest. YOU may have a particular problem with which we can assist. Let's talk it over.

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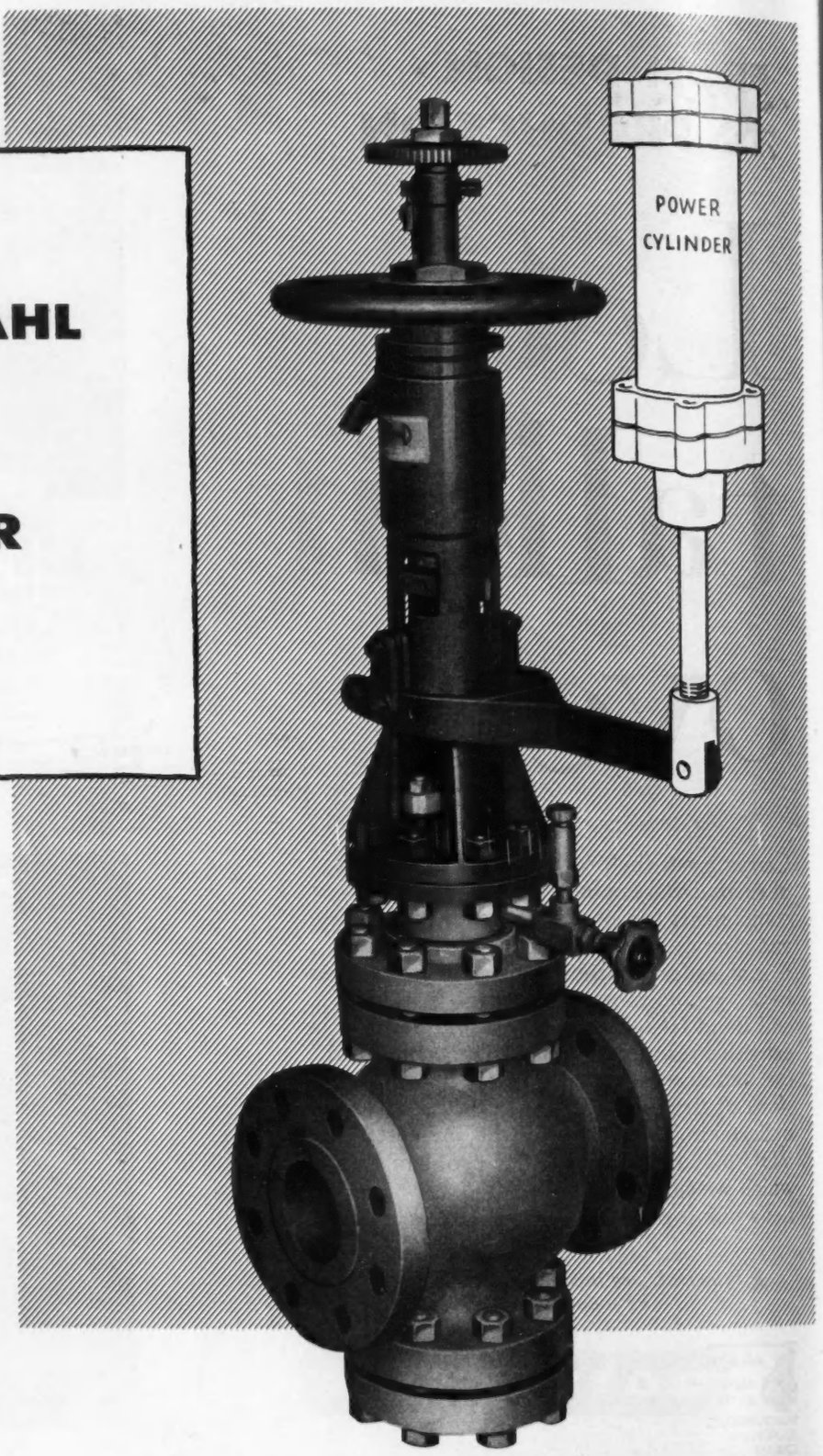

To meet the exacting requirements of automatic feed control on modern high pressure, high duty boilers, flow regulating valves of Hammel-Dahl type are being increasingly adopted. Orders have been executed, or are at present in hand, for installations at a number of plants, including the new Willington power station of the Central Electricity Authority.

The valves are of special construction, with chrome molybdenum steel bodies and appropriate trim, to withstand the severe effects of throttling at high working pressures; and are furnished with double seated plug, fully characterised to give the required flow-lift relationship. Normally positioned by the power cylinder of the controller, the valve can also be operated manually at any time.

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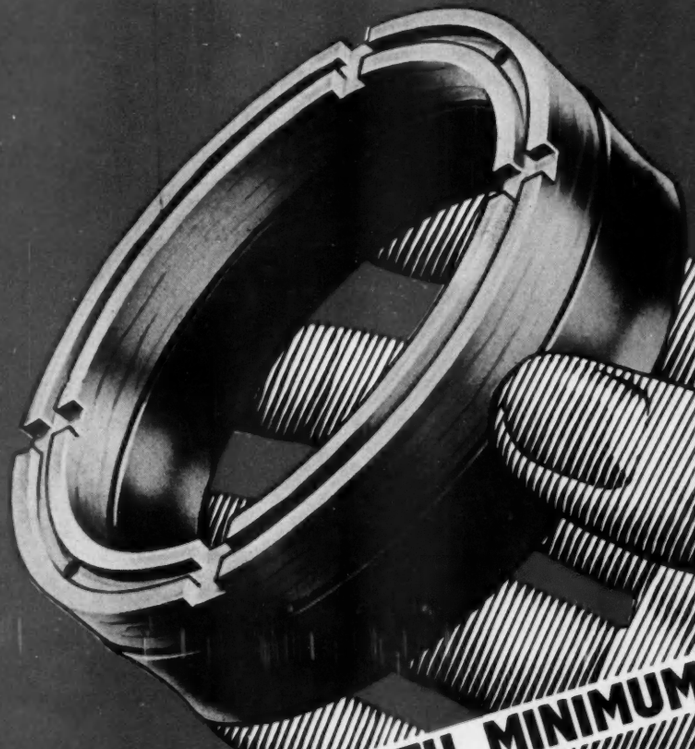
'LION' TWINSET



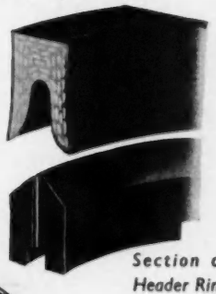
SEALING PERFECTION WITH MINIMUM OF FRICTION

'Lion' Twinset is undoubtedly one of the most efficient packings in the world for stuffing boxes where an endless ring can be recommended and where friction must be reduced to a minimum. It has been specially designed for use on vertical reciprocating shafts or rams, and is made in materials suitable for a wide pressure and temperature range.

The lips of the 'U' ring on 'Lion' Twinset are slightly tapered. This ensures initial interference and an immediate seal. The Header Ring which is 'V' shaped is grooved and drilled to conduct the pressure medium into the tongue shaped cavity of the 'U' ring to create automatic lip action and a positive seal under pressure.

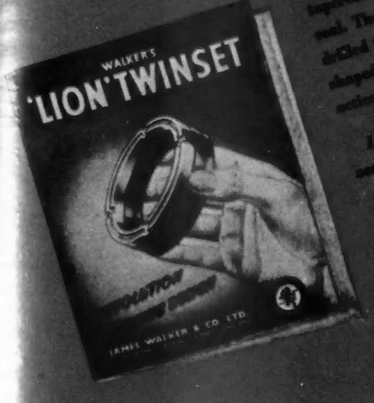
Learn more about 'Lion' Twinset—send today for illustrated folder.

Section of 'U' Ring showing tapered lips



Section of Header Ring

WALKER'S LION PACKING



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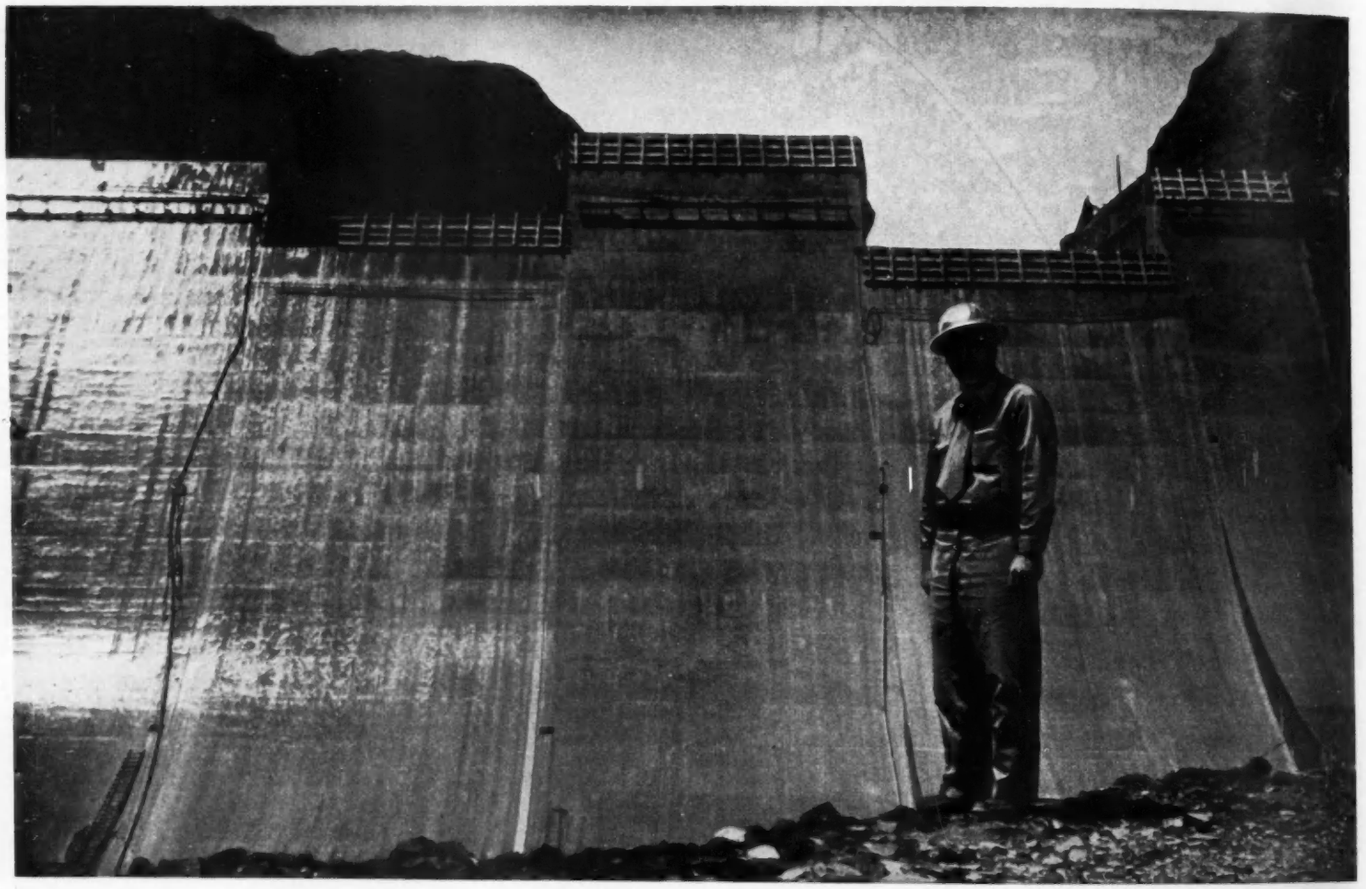


Hundreds of Atlas Copco rock drills, together with Atlas Copco rock breakers, pneumatic pushers, compressors and Sandvik Coromant drill steels, are in action on large-scale quarrying, excavating and tunnelling operations for Turkey's biggest hydro-electric project. It is at Sariyar on the Sakarya River, about 150 km. west of Ankara. A huge power station will have an initial capacity of 80,000 kilowatts and the project is expected to be finished by 1957.

50 DRILLS QUARRY ROCK FOR DAM

Rock for a concrete gravity dam 330 feet high and 820 feet wide across the top is supplied from a nearby stone quarry. By the time the dam is completed 650,000 cu. yards of rock will have been quarried. This work is mainly being done with fifty Atlas Copco rock drills. The drills are fitted with Sandvik Coromant tungsten-carbide-tipped steels. The dam is being built for Etibank, and the construction supervisors are Chas. T. Main, Inc.

Besides the dam, Atlas Copco equipment and Sandvik Coromant steels are used on the surge tank, penstocks and two tunnels. The first one, 7,000 feet long and 30 feet in diameter, is completed. The second, to be 3,100 feet long and also 30 feet in diameter, was started in the middle of 1954 and almost half-completed by the end of that year.

POOR ROCK STOPS TUNNEL WORK

With unexpectedly poor rock formations, hold-ups were many. In the first tunnel a cave above the outlet side caused a collapse of earth and rock, blocking the tunnel and delaying further work for six months. But when conditions permitted a full face advance, as many as thirteen Atlas Copco light rock drills were in action at one and the same time in a comparatively small drilling area.

MORE DRILLS AND FASTER TIMES

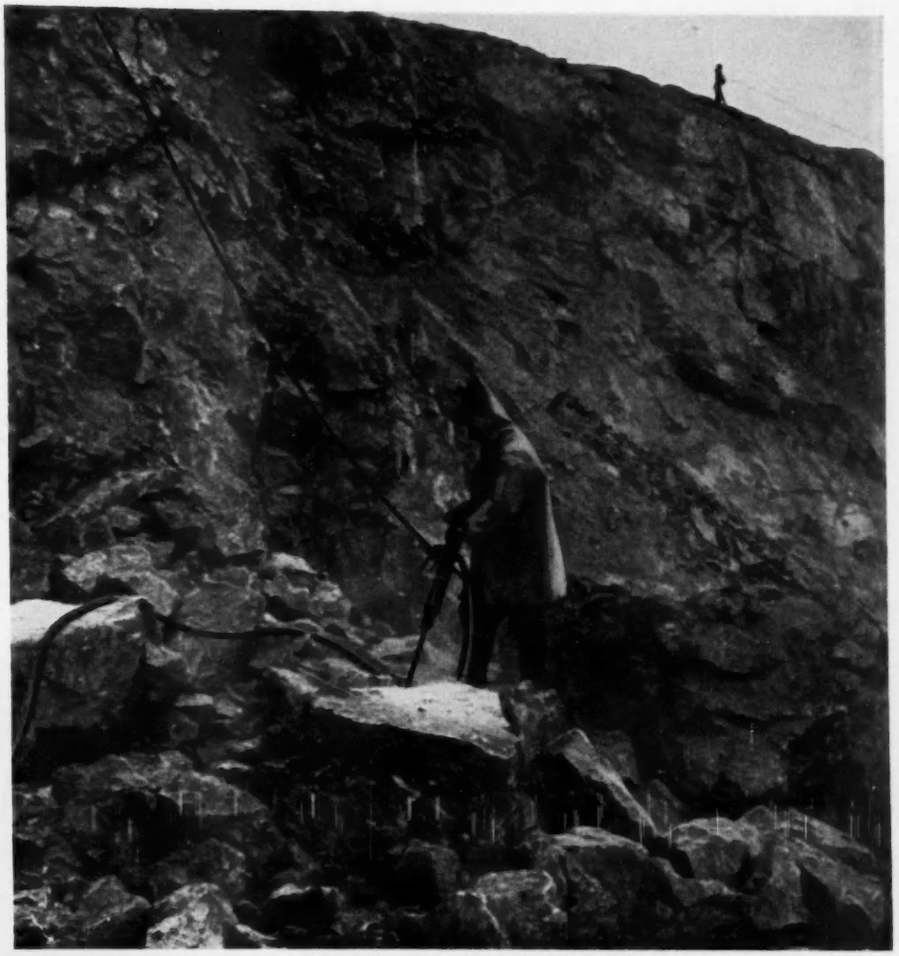
Atlas Copco light rock drills are compact, *one-man* machines. That saves space; means *more* drills at the face and, consequently *faster* drilling times each round. Atlas Copco rock drills with Sandvik Coromant steels are an unbeatable *lightweight* drilling unit. In ten years it has extensively replaced heavy equipment to become the world's most widely-used rock-drilling combination.

EXTRA T.UGH DRILL STEELS

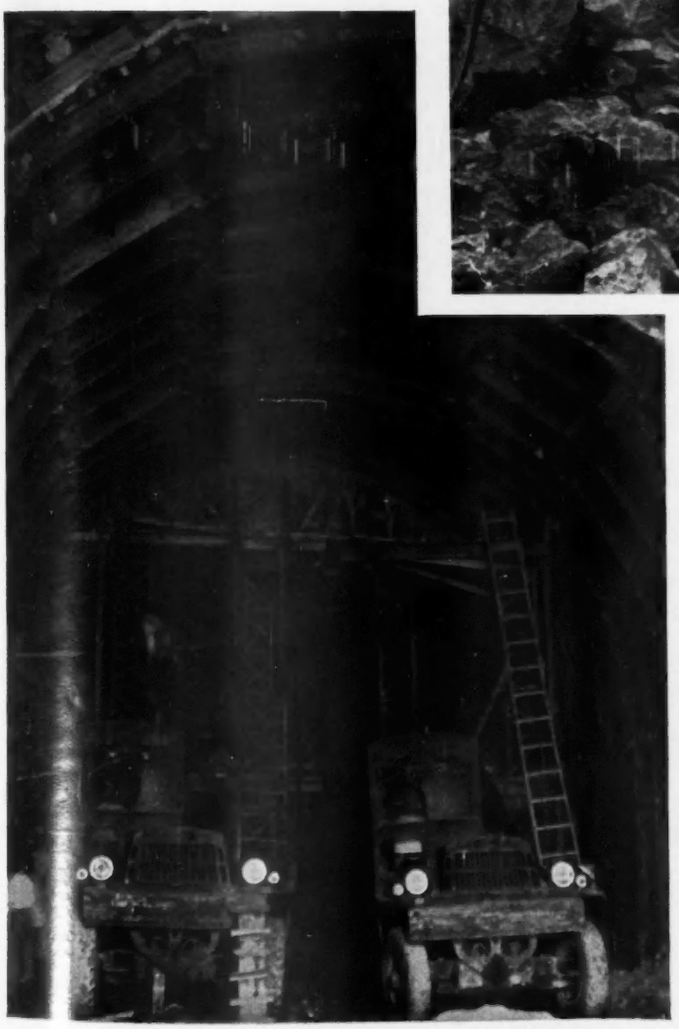
Atlas Copco rock drills were developed to work with Sandvik Coromant steels. Sandvik, to maintain a never-varying drill steel quality, control every phase of production—from the mining of iron ore, processing of wolfram ore to the final, *extra-tough* tungsten-carbide inserts used throughout the world wherever Atlas Copco rock drills are in action.

The main contractors building the dam for Etibank are Philipp Holzmann A.G., Hochtief A.G., Siemens Bauunion G.m.b.H., and Rar Türk Limited. Sosyetesi. The construction work was supervised by Chas. T. Main, Inc.

The Atlas Copco Group puts compressed air to work for the world. It embraces thirty-one Atlas Copco companies and twenty-four agents, manufacturing or selling and servicing Atlas Copco equipment in more than 50 countries throughout the world.



Fifty Atlas Copco rock drills fitted with Sandvik Coromant steels are excavating 650,000 cu. yards of rock for the dam.



Entrance of first diversion tunnel. Tunnelling is taking place from jumbos, mobile drilling platforms developed by Atlas Copco, following patterns drawn up by their Project Department.

For further details about Atlas Copco Equipment write to the most convenient of the addresses given here:

UNITED KINGDOM, Atlas Copco (Great Britain) Ltd., Wembley, Middx; FRANCE, Atlas Copco France S.A., 29, Rue Marbeuf, Paris 8e; HOLLAND, Atlas Copco Holland N.V., P.O. Box 6056, Rotterdam; ITALY, Atlas Copco Italia, S.p.A., Viale Marche 15, Milan. TURKEY, Atlas Copco Ticaret ve Sanayi T.A.S., P.O. Box 490, Galata, Istanbul.

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Readers in countries outside those listed above and who do not know the name of their local Atlas Copco company or agent, please write to Atlas Copco AB, Stockholm 1, Sweden.

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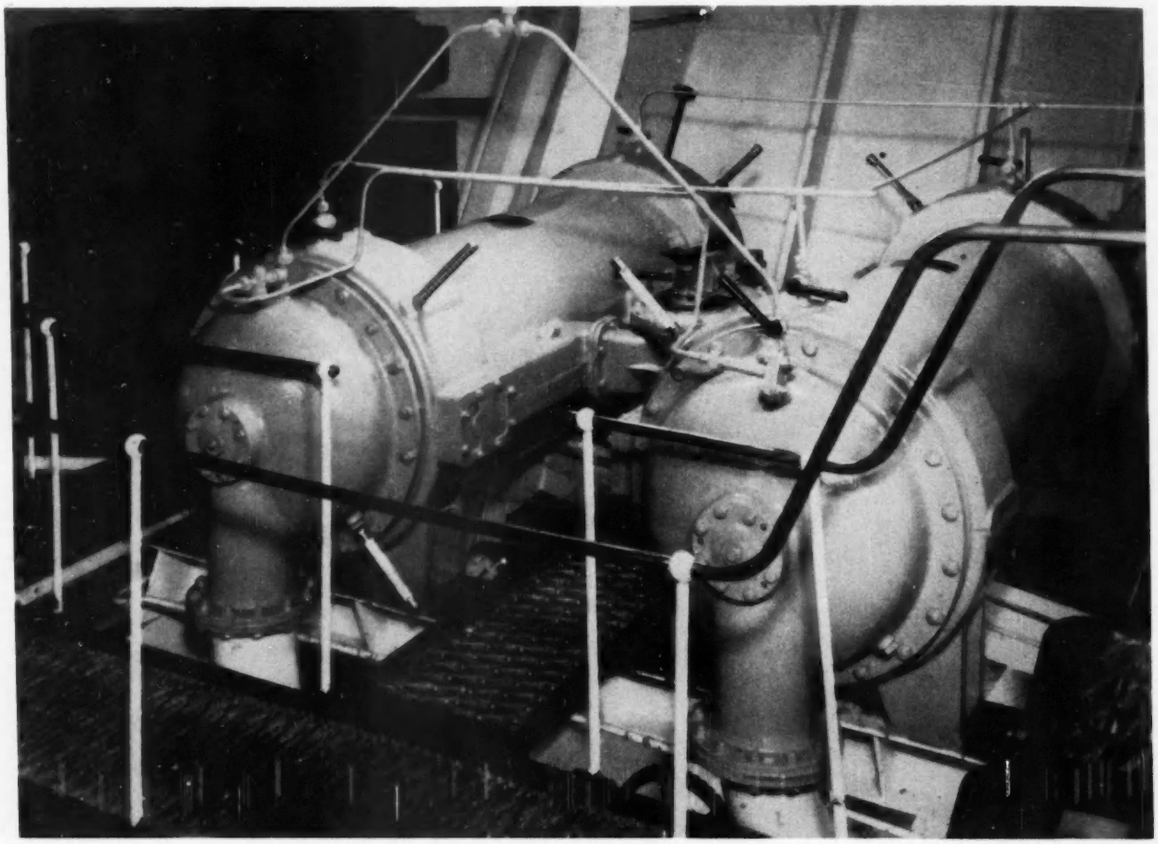
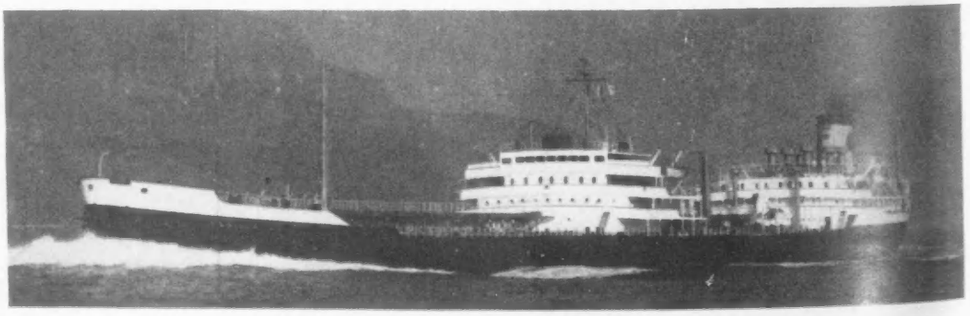


Over the seas with Serck

With atomics still in its infancy and coal growing scarcer and scarcer, oil is destined to become the principal source of power for the next two or three decades. Ever-increasing demands for petroleum products are responsible for the current extensive tanker building programmes in British and Continental shipyards.

Already in the nuclear picture, Serck maintain their supremacy in present-day heat transfer engineering with equipment like the Bled Steam Air Heaters and, illustrated here, Duplex Turbine Oil Coolers, fitted to Shell Tanker 31,000 ton "Vexilla".



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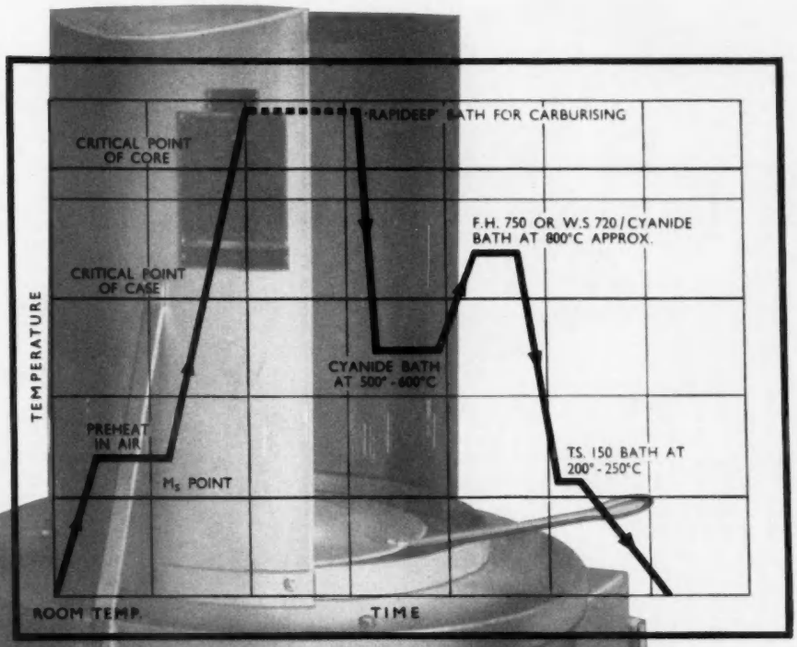
for casehardening heat-treatment brazing...

The 'Cassel' Heat-Treatment Service offers a complete range of salts, furnaces and technical advisory facilities to meet all problems. For instance, considerable reduction in distortion during casehardening of alloy steel gears can be effected by a complete treatment cycle in salt baths, including carburising and martempering. This is, in part, due to the even heating possible in salt but also because the steel passes through the range of martensite formation only once during this casehardening process. The method is being applied on a production scale to gears, shafts and sliding dogs.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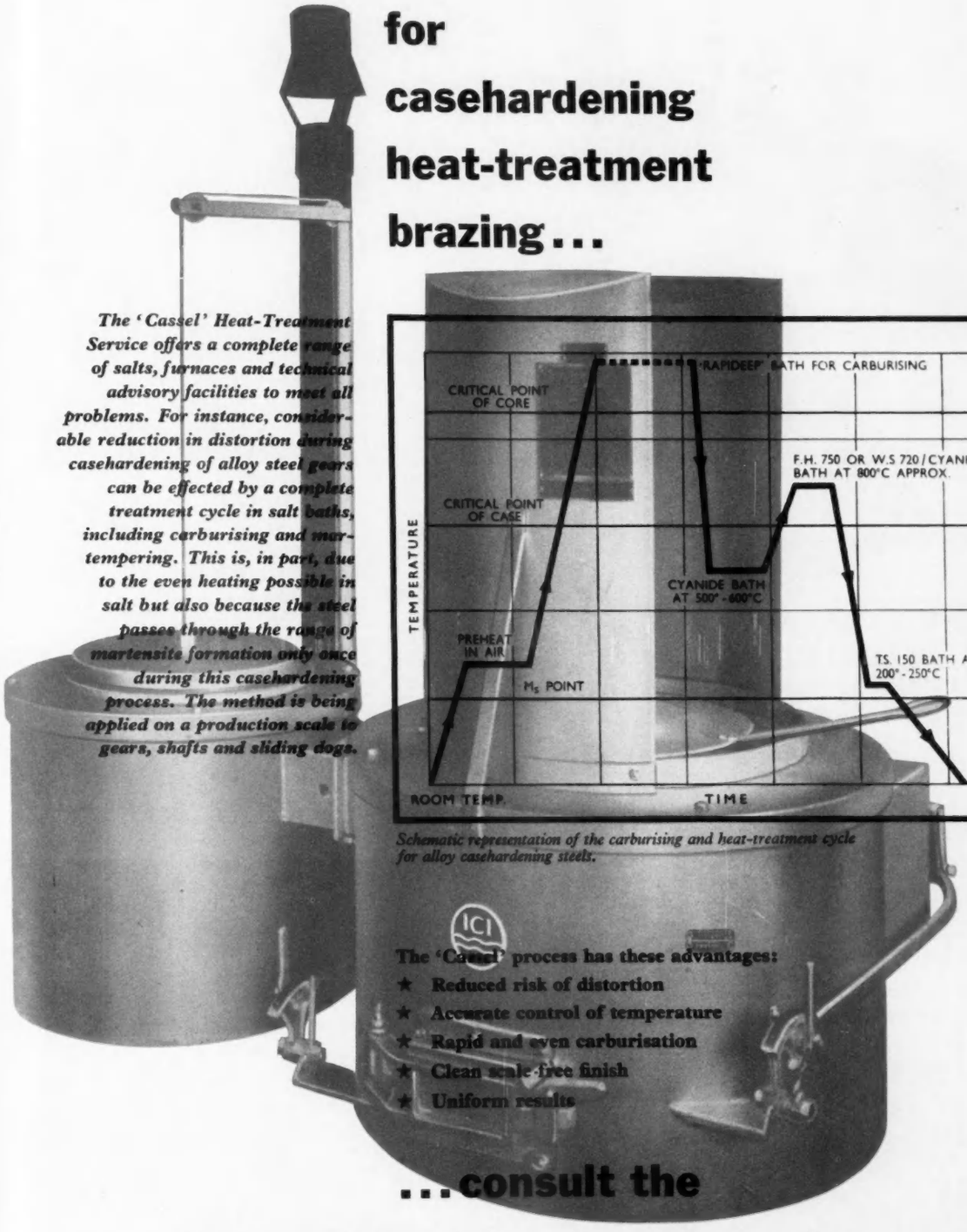
TIME

Schematic representation of the carburising and heat-treatment cycle for alloy casehardening steels.



The 'Cassel' process has these advantages:

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- ★ **Clean scale-free finish**
- ★ **Uniform results**

...consult the 'Cassel' heat-treatment service

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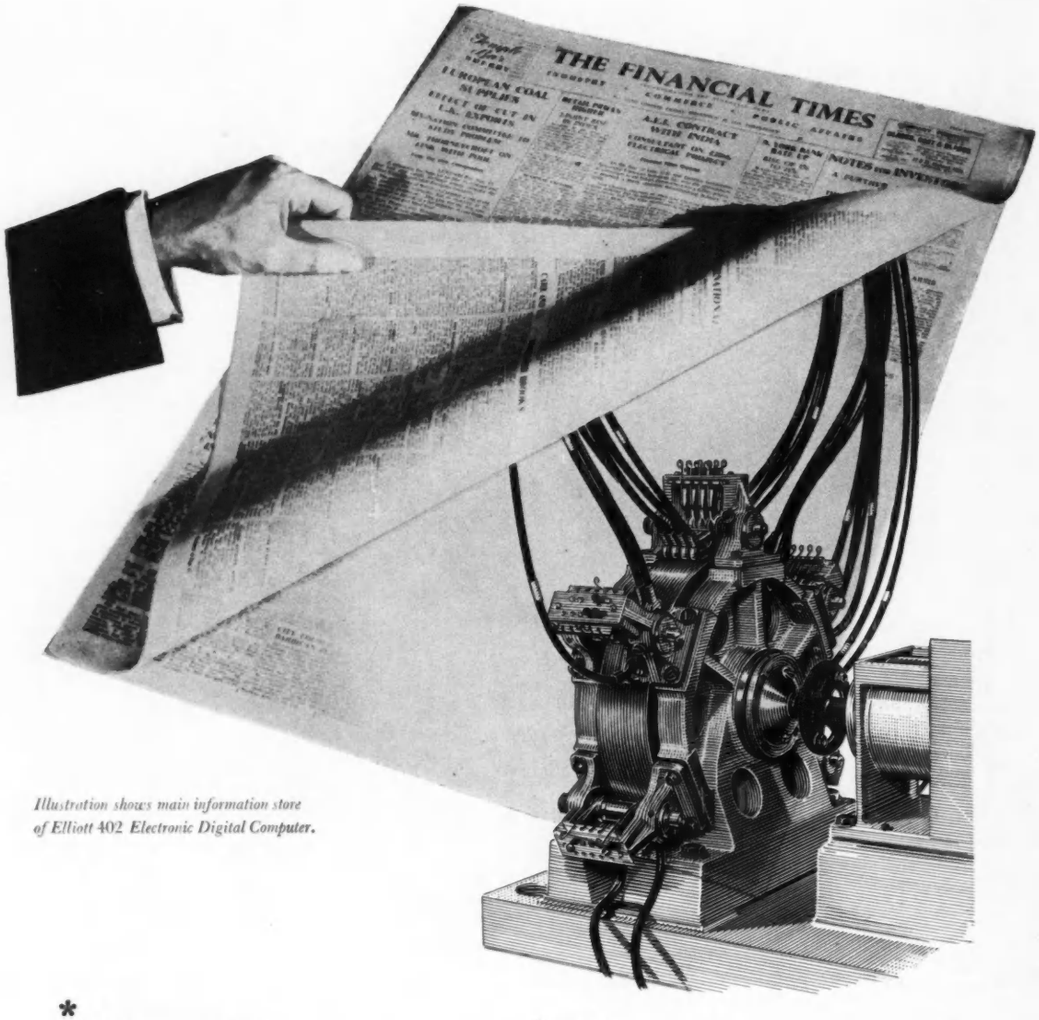

Illustration shows main information store of Elliott 402 Electronic Digital Computer.

*The Brains of Automation...

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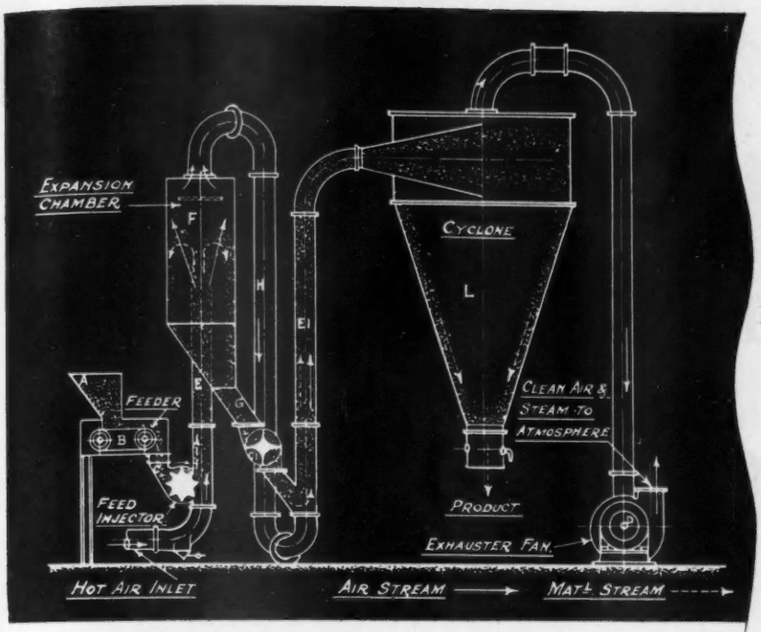
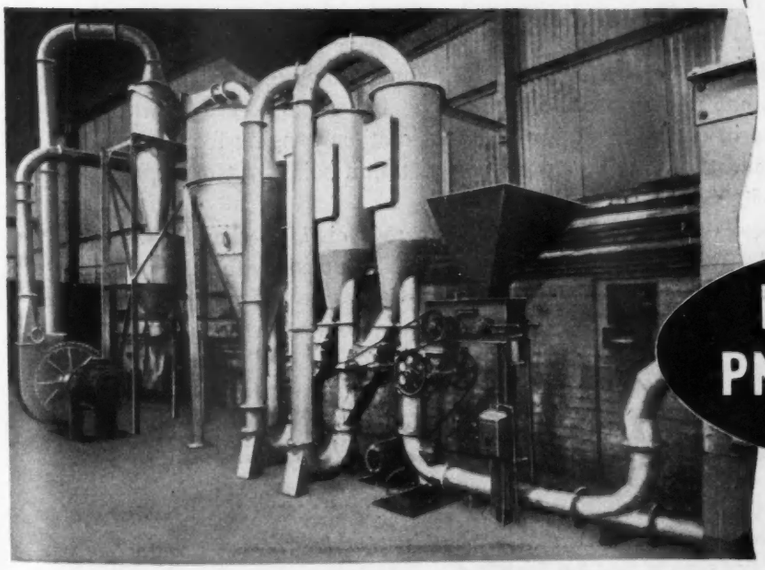


it's all done by hot air

For drying small coals the British 'Rema' Pneumatic Dryer is quick and effective, and takes up relatively little space.
At all times during the drying the particles are separated and swept by high-velocity hot gases; this gives an extremely rapid transfer of moisture from material to the air stream—drying takes place in less than one minute and the material never has time to get too hot.
This system of pneumatic drying is also very suitable for materials which are easily damaged by breakage or over-heating —flaked materials, crystalline products, sawdust, etc.
Sizes: from ½-ton to 20 tons per hour.



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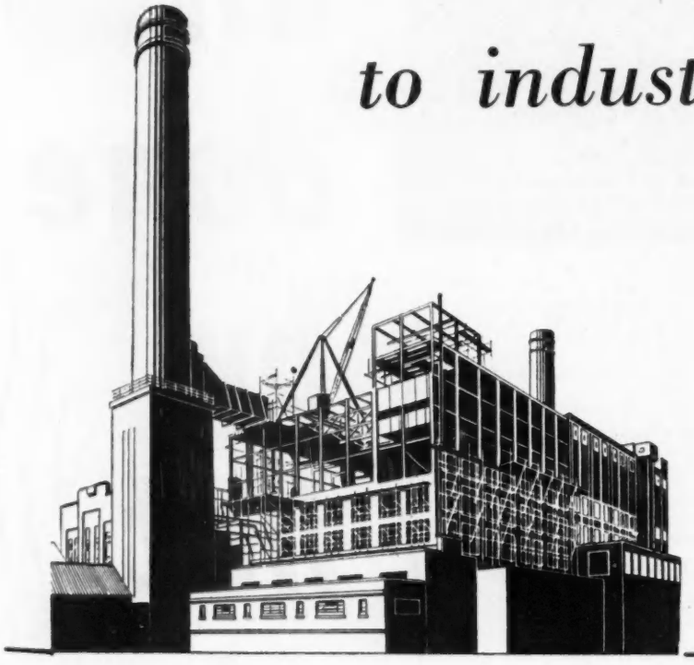

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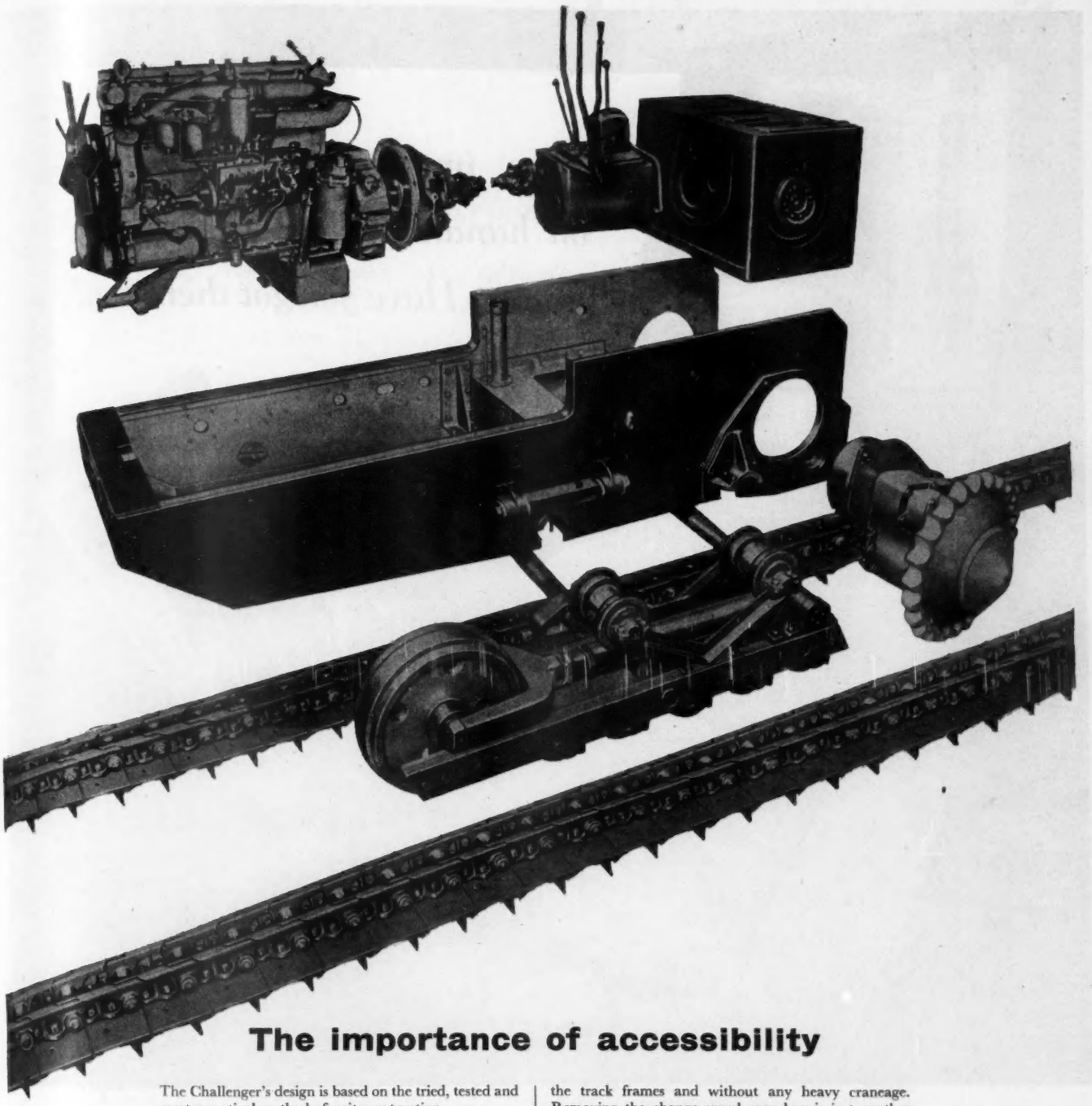

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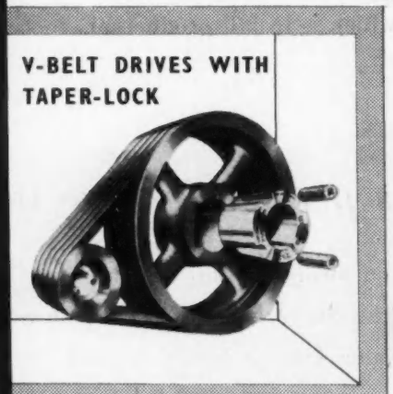

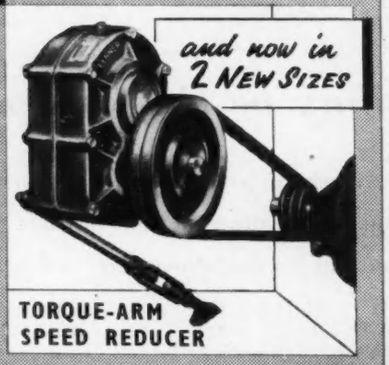

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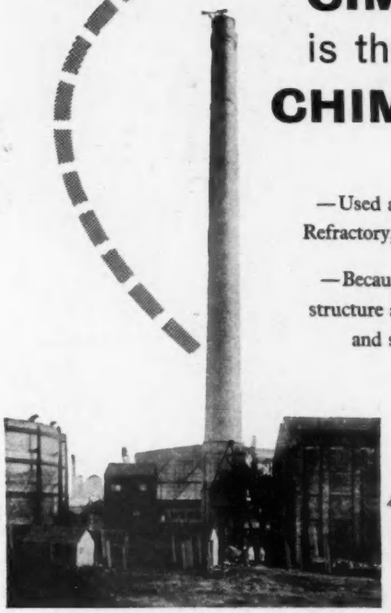

Wallasey Power Station. Ciment Fondu mortar was used for the jointing of the interior brickwork of this chimney.

Shell's Shellhaven Refinery, Essex. These 9 ft. diameter steel stacks have been lined with Ciment Fondu insulating concrete.

Battersea Power Station where chimneys have been lined with Ciment Fondu mortar.

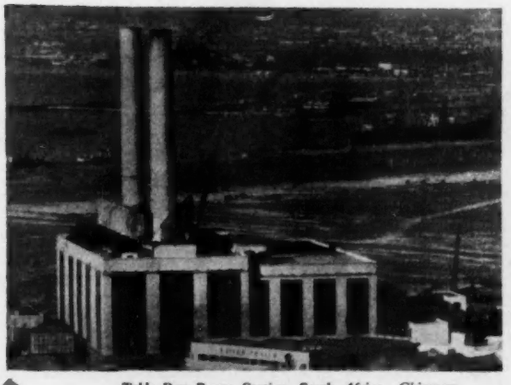

Table Bay Power Station, South Africa. Chimneys gunited with Ciment Fondu mortar.

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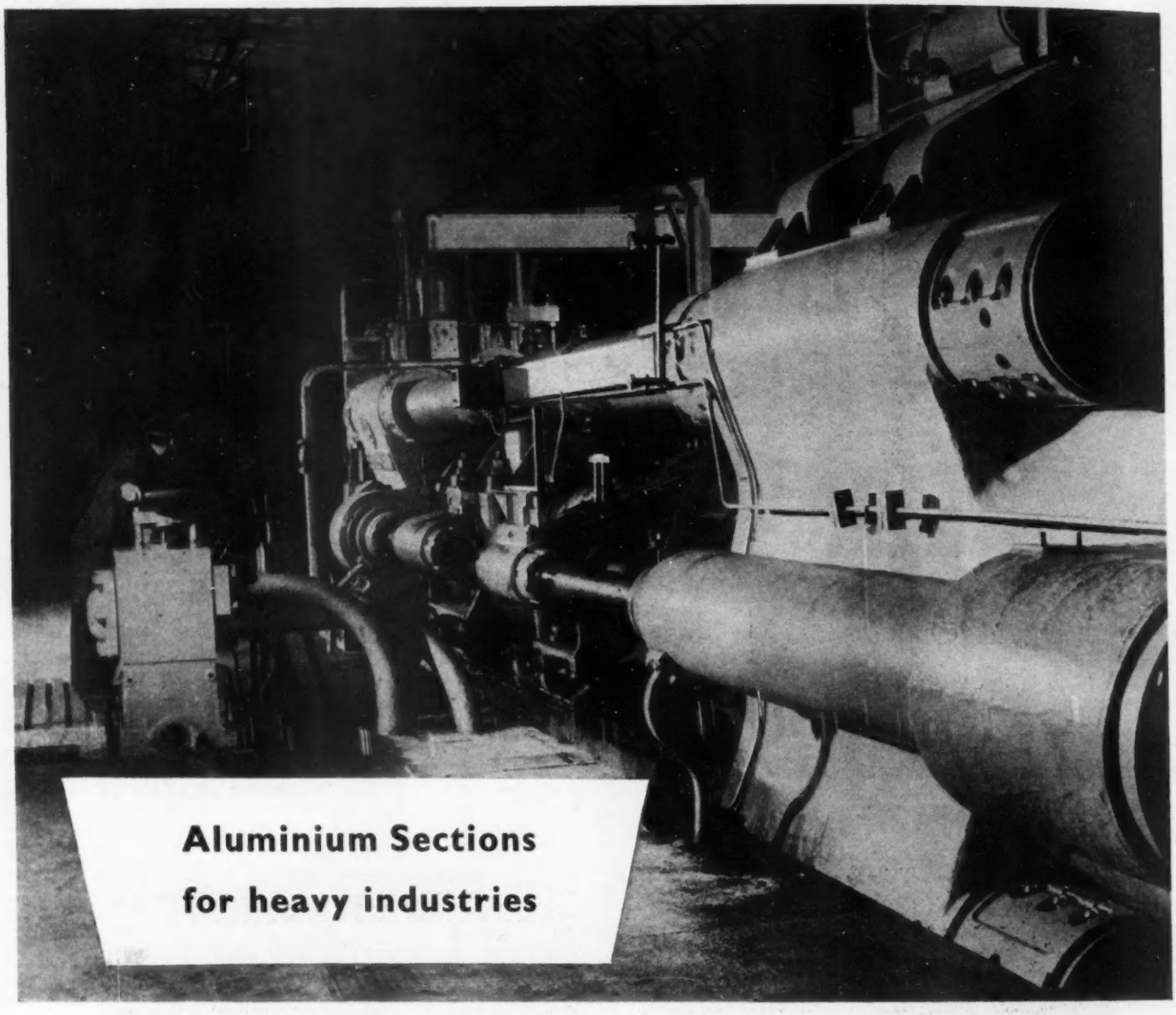

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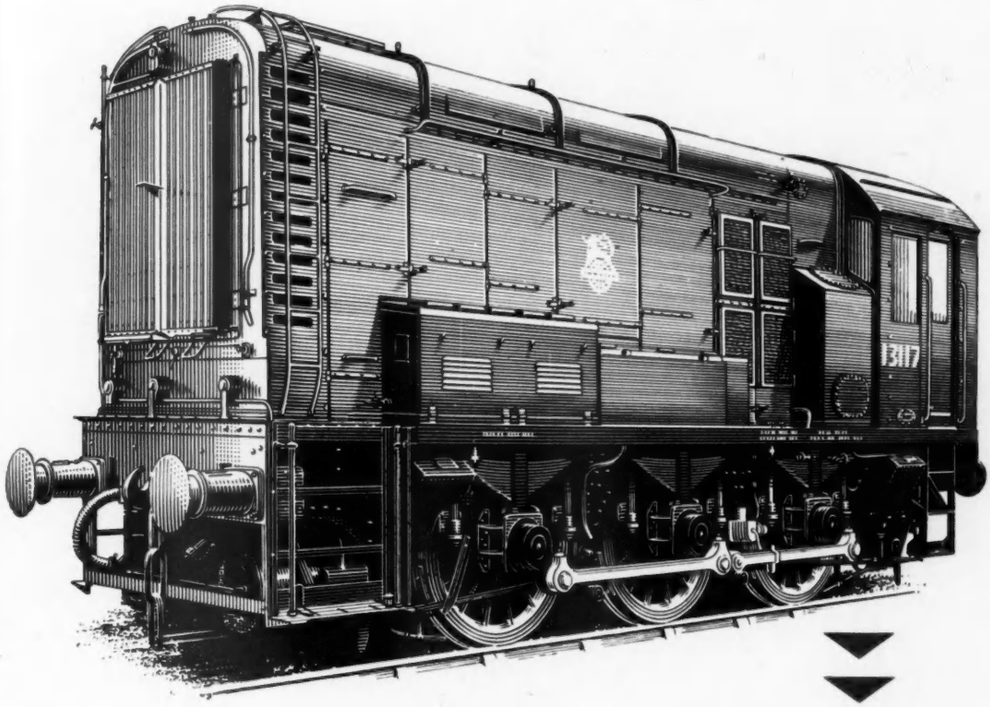

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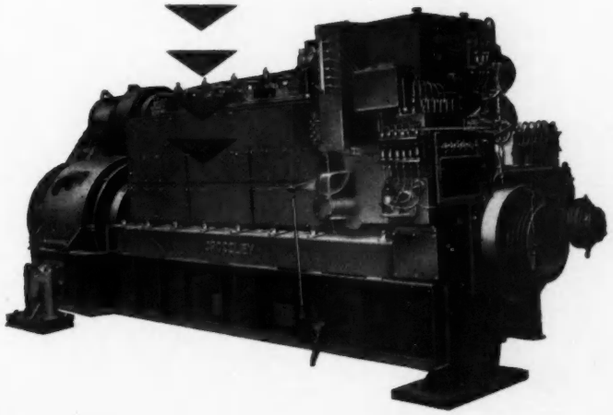

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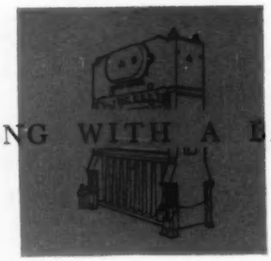

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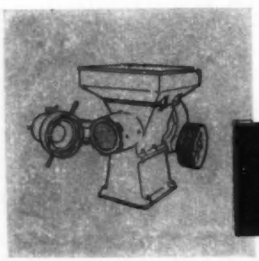

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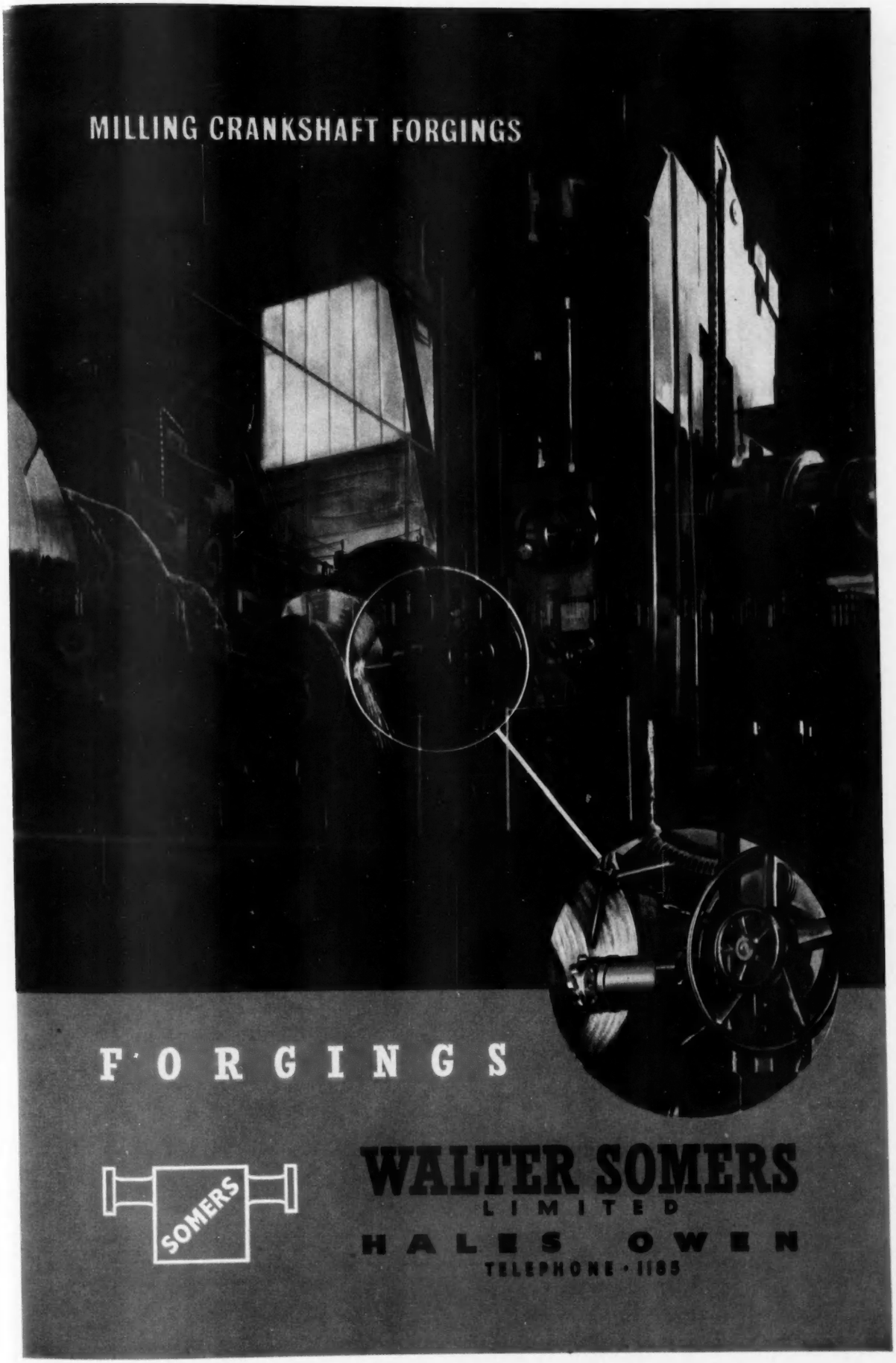
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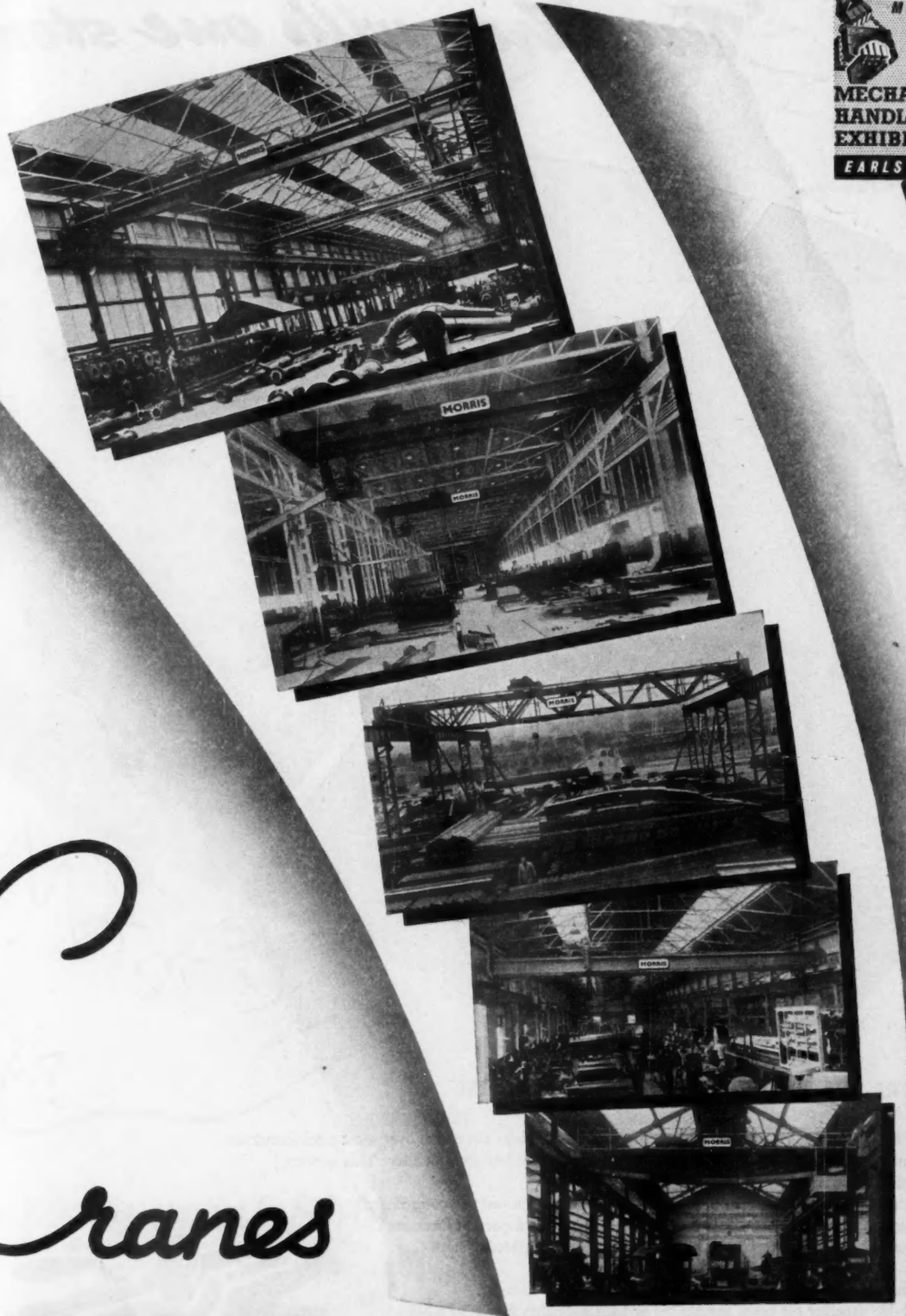

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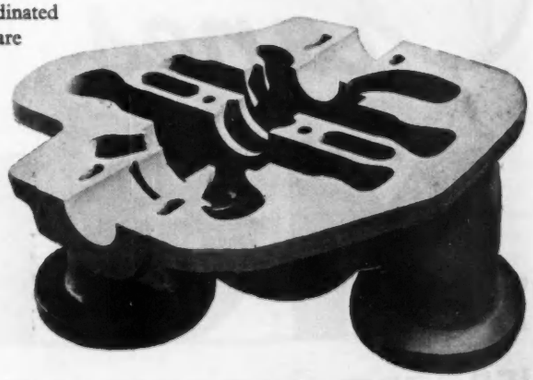

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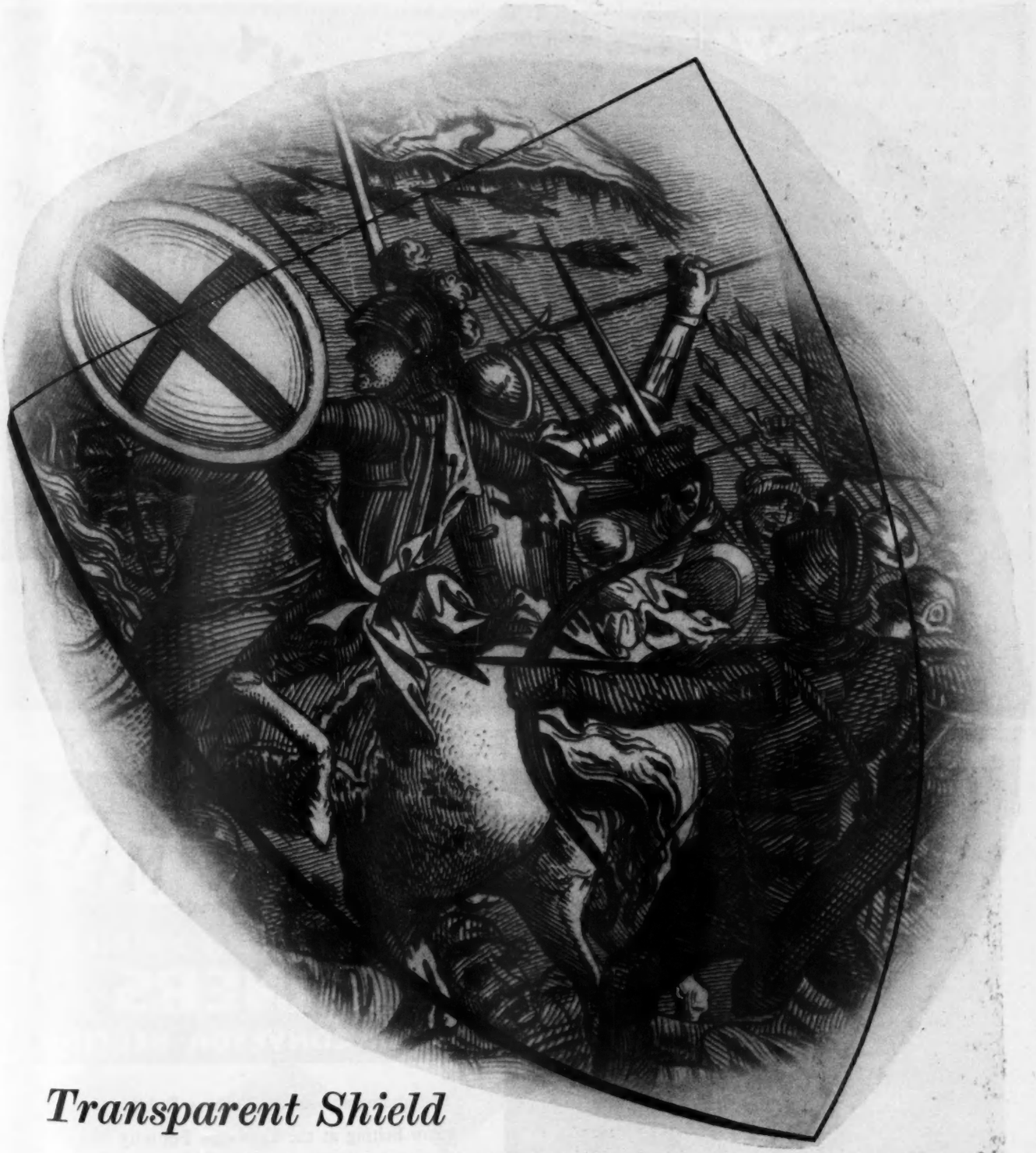

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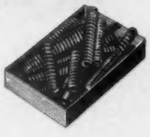

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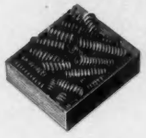

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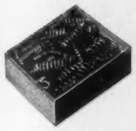

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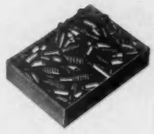

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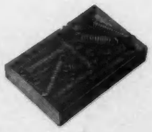

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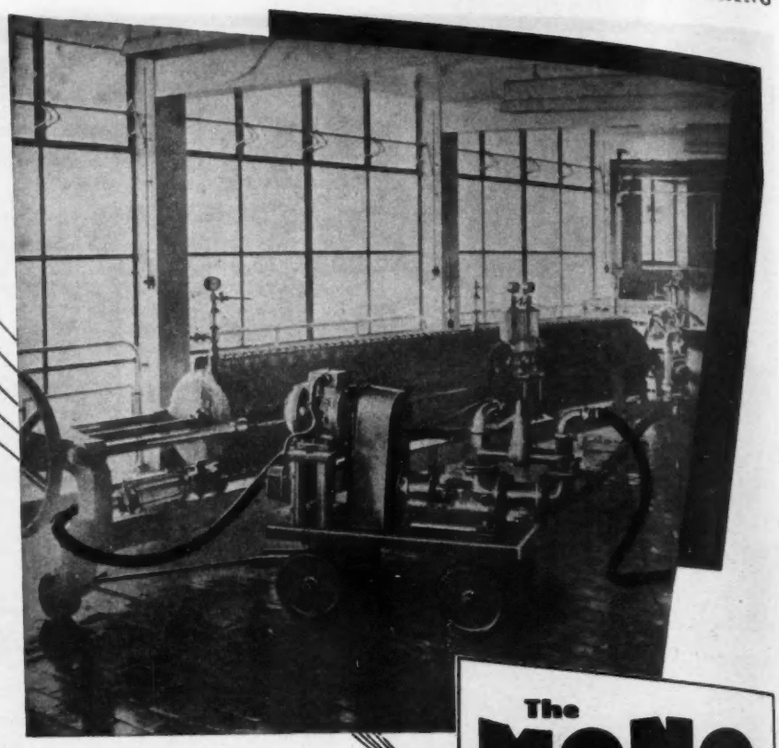

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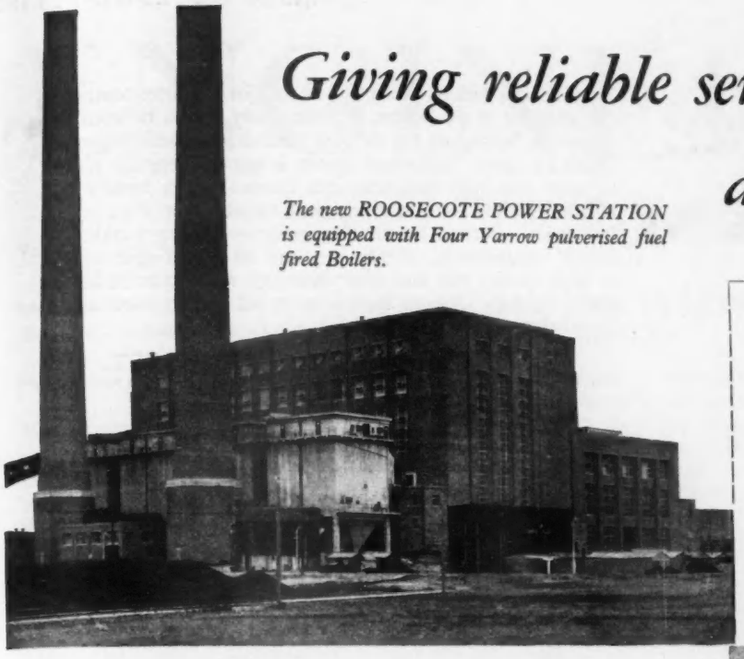

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ENGINEERING

An Illustrated Weekly Journal

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HUMAN AND ELECTRONIC BRAINS

THE interest which is being taken in the design, performance and application of digital computers, both in engineering and commercial circles, was exemplified by the attendance at the Convention held at the Institution of Electrical Engineers last week. Not only was the main lecture theatre crowded at the opening session, but it was necessary to arrange two overflow gatherings at which, not inappropriately, good use was made of sound and vision reproducing equipment. This interest is not surprising, for although a perusal of the 60 or so papers presented will probably induce in the non-expert something like an inferiority complex, they show that machines have been devised which should go far to remove a good deal of drudgery from human life. What is to take the place of this drudgery remains to be seen.

As Sir Cyril Hinshelwood pointed out in his opening address to the Convention, the present position in the development of these machines has been reached as the result of the confluence of many tributaries of human thought. Associated with these has been the perfection of the thermionic valve and its alternatives without which, indeed, we should probably not have advanced beyond the stage of Babbage and other early workers. As it is, the ability to make complicated calculations and computations more rapidly and more efficiently gives rise to the speculation whether machines a good deal more complex than those hitherto demonstrated can be developed. Electronic computers provide analogies to the functioning of the brain. It is true they cannot "programme" themselves, but their performance is not dissimilar to that of the mind, since they carry out routine operations until the conditions specified by their instructions have been fulfilled. The analogies between their calculations and thinking have therefore reawakened the old argument about behaviourism, and aroused interest in a field where electrical activities do not usually penetrate.

In the engineering world, the full significance of electronic computers is gradually spreading among people who can apply them to the control of production. A sense of frustration will arise if spectacular results are expected too quickly. What is required in the years ahead is persistent study by engineers and executives into the possibilities of electronic computers—especially by those whose instinctive reaction is that these complex machines are only applicable to continuous processes and mass production. The opportunities are more widespread than that. In a special article in this issue Sir Walter Puckey expounds the opportunities in language that will be readily understood by engineers who are not familiar with the language of computer engineering.

★ ★ ★

A boy leaving school in this country is more likely to enter one of the older professions—law, medicine, army or church—if his family are relatively high in the social scale. That has been the accepted pattern for centuries, but it is slowly changing. Increasing numbers of such boys will be taking up science or engineering in the future.

The change comes not a bit too soon. In a famous paper to the British Association in 1954, Mr. Bosworth Monck showed that there were far too few engineers in managerial positions. The leaders in industry tend to be barristers, solicitors, accountants, salesmen and the like—not because these professions qualify better for high positions than the profession of engineer, but because, in general, they probably contain a higher proportion of men who have had a public school education. Such an education is strong in developing qualities of leadership and independence. And boys who have been educated in this way are increasingly needed to train for the top posts in industry.

A group of 90 industrial firms have subscribed £2,900,000 to the fund which was established last year—the Industrial Fund for the Advancement of Scientific Education in Schools. By making capital grants towards the building, expansion, modernising and equipping of science laboratories, the fund will help independent and direct-grant schools to teach science in a manner that accords with the character of their educational system. The grants are "to be restricted to the teaching of the fundamental sciences of physics and chemistry, and of mathematics." Clearly, there is no intention of turning out embryo mechanics—boys able to use a file or operate a lathe. In placing that restriction on the use of the fund, the organisers have decided wisely. Some boys, after school or university, will wish to gain practical experience—they can gain it most effectively when they go into industry for an apprenticeship or sandwich course; others will wish to avoid practical engineering and go in for a branch of science or administration—they will not have wasted time in a school workshop.

About 440 schools have applied for grants from the fund, and the first grants have already been made. It will be several years before the value of the fund accrues to industry, but the investment is undoubtedly an imaginative and far-seeing move.

Plain Words

The Committee Stage of the Government's Restrictive Trade Practices Bill is now proceeding through the House of Commons and is attracting a great deal of interest. Over three hundred amendments had been tabled before the debate began last week. The Bill is of considerable importance to the engineering industry, for it proposes to stamp out collective price maintenance which for many years has been an essential feature of the distribution of many engineering products. The Association of Engineering Distributors, not themselves concerned with price maintenance, consider that its abolition would probably lead to cut-throat competition. In their view, the manufacturer needs the assurance of "a reasonable profit margin" to maintain the quality of his products, and to carry out technical research and adequate development work. The distributor whose profit margins are unsafe cannot be expected to carry adequate stocks nor continue to give the necessary technical service to his customers.

The Federation of British Industries, the National Union of Manufacturers and the Association of British Chambers of Commerce do not oppose the main object of the Bill (the prohibition of certain restrictive agreements when found contrary to the public interest) nor do they object to the procedure set out in the Bill —the setting up of a judicial tribunal to pronounce on individual agreements which fall within the prescribed registerable classes. In their view, restrictive practices are neither always in the public interest nor always to its detriment: "Very often the judgment must depend on striking a balance between good and bad effects." These bodies' main objection is that the Bill instructs the Tribunal to proceed on the assumption that every restrictive agreement is against the public interest unless it is proved to the contrary. The onus of proof is on the accused, not on the Court. They also oppose the decision to ban collective price maintenance out of hand.

The opposition to the Bill has so far come mainly from the Labour benches, on the grounds that it (*a*) is unlikely to be effective, i.e., full of loopholes, and (*b*) that the registrar of the court, who is to be appointed by the Crown on the advice of the Prime Minister, is not responsible to a Government department and therefore not answerable to Parliament. This being so, they argue, how can the Government of the day ensure that their trade and commercial policy is correctly interpreted? They prefer political and administrative controls to juridicial action which, they fear, will be slow, tortuous and ineffective. Opposition from Conservative backbenchers centres more on the legal powers of the court, which many consider unwarranted interference with an industrial function on grounds that are dangerously vague. What is "the public interest" the Court will seek to protect? And why should the specific grounds on which exemption can be claimed (clause 1*b*) be limited to seven? They want to add an eighth: that the removal of the restrictions would do more harm to its operators (or third parties) than it would do good to others.?

Few can doubt that the implications of the Bill on the engineering industry are far-reaching, and that in its present form would create several major problems for large sections of the industry. But the really restrictive practices, such as the acquisition of patents to suppress a new product, or the purchase of an enterprising company to keep down competition, do not appear to be adequately covered in the Bill. There will, of course, be a great deal left to the initiative of the registrar and also to that of the President of the Board of Trade. There seems to be too much that is vague, too many grounds for exemption and too much left to the discretion of the Court. It is open to doubt, therefore, that this Bill, if it becomes law, will help industry to foster a more dynamic approach to technological change and a more competitive spirit in foreign markets. Yet, those are the prime needs of our economy.

THIS IS WHAT AUTOMATION CAN DO

By Sir Walter Puckey

Every day the word AUTOMATION stares back at us from the pages of newspapers, technical and lay journals, and lecture programmes. It has seized popular imagination, and because of that must necessarily be of great interest to all who are concerned with satisfying popular demand. Let us look behind the word and see how much depth exists.

Is it just a new wrapping around an old bottled labelled, for instance, "Mechanisation 1956," or is there a new sort of liquid in the bottle, more potent and powerful than others? The word "control" is often associated with automation and we are told that "control power" is the new ingredient which, when added appropriately to existing contents, makes all the difference—in fact produces automation. What is control power and how does it drastically alter something to the stage where the combination may result in an entirely new thing?

To control is, briefly, to restrain, govern or direct. Its application ranges from the Chancellor's Budget to the pressure valve of an air container, and between these widely differing examples lie thousands of others in hundreds of jobs, trades and industries. Even the most enthusiastic devotee of automation is hardly likely to claim for it an ability to provide better results in all of these fields, yet an analysis may isolate some principles which might guide us towards more effective control, whether we be members of a government, managers, or engineers.

Before attempting a brief analysis, let us ask why control seems to be such a necessary and desirable thing to improve. It seems to me that the following factors have, for one reason or another, assumed greater importance over the last few decades:—

(1) Full employment.
(2) Centralisation of authority.
(3) Speed of communications (internal and external).
(4) Precision of stated requirements.
(5) Flexibility to accommodate rapidly changing requirements.
(6) Machine power to multiply scarce manpower.
(7) Skill-power to provide and operate more machine power.
(8) Managerial power to control men and machines.

It is easy to see that five words are dominant: men, machines, communication, precision and and control. Let us briefly re-state the reasons for their importance.

Men.—Full employment has forced us to give greater attention to the use and misuse of men.

Machines.—If manpower is limited, greater machine power to multiply man's power is the obvious answer.

Communication.—Greater centralisation of management decisions has been made necessary by international trends, affecting both Government and private enterprises. The longer and more numerous the lines of communication to, from, and around the periphery the more important communication becomes, owing to the greater the need, under full employment, to consult, conduct and control men. Good communication must be rapid and multi-directional.

Precision.—Greater precision is needed in dealing with men and machines: with men, because misunderstandings create graver repercussions under to-day's conditions; with machines because higher performances and more precise and rigid specifications cause us to demand much more from machines.

Control.—Restrain, govern or direct—which is the appropriate definition to use? Certainly the most important form of control required to-day is managerial control, applied by more and better managers. But managers are increasingly required to control not only men, but the relationship between men and machines, because with limited manpower a feature of the next few decades will be an even greater expansion of machine power to benefit men.

Good control is therefore the dominant theme. It is concerned with men and machines; it must provide itself with a good communications system and be capable of achieving higher standards of precision in its results.

THE MANAGER'S TASK

Here then is an important part of the managerial formula for a successful future. A company whose managers understand men and machines, can communicate well between all grades and neighbours, and has precise standards of measurements and achievement, is certainly very near success, whether it makes engines, runs a transport system or lends money. It has good managers, whether they were originally trained as engineers, accountants or lawyers.

But—and let us try to avoid bias—are those who are not trained as engineers likely to understand adequately the technical considerations and solutions of the future? The tremendous technical researches of the last few decades, ranging from nuclear energy and electronics to startling new materials and products, ensure that the years ahead will make progress increasingly reliant upon those who understand the principles and wider applications of this technical work. Let us not forget, however, that managers must also understand men, and despite the development of social sciences there is still a vast area of managerial responsibility where personal characteristics and qualities are more important than scientific and technical knowledge.

It is not within the scope of this article to dwell at length upon these personal characteristics, whether possessed by those who control or those controlled. Sufficient to say that engineers are increasingly realising that technical progress will only be as rapid as its acceptance by men and women. Engineers will be good managers only when they study men and the possibilities of the social sciences as intensely and intelligently as they study their own practice and theory.

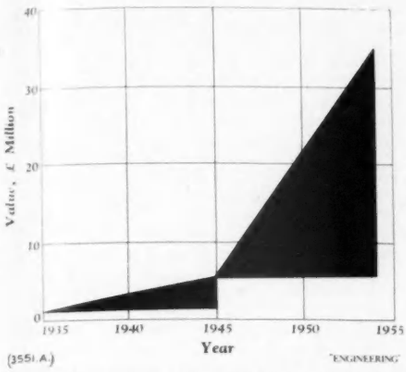
TECHNICAL CONTRIBUTION TO MANAGEMENT CONTROL

Having mentioned this basic necessity, let us now revert to technical considerations and examine how scientists and engineers may help themselves and fellow managers by adapting their new discoveries to the field of managerial control; in particular, what technical contribution can be made by us to the control of men and machines, and to the setting up of an effective communication system, ensuring more precise results?

MAN-CONTROL BY THE MACHINE

The machine has already substantially eased man's muscle burden, although so far in limited areas and industries. In Britain, mechanisation has been applied much more intensively to those eight million people on the factory floor than to the sixteen million who make up the rest of our employed population. In the "office" group (about eight million) a rapid extension of mechanisation is now taking place and the £1,500,000 turnover of British office machine producers in 1935 expanding to £39,000,000 output last year. This rapid growth will continue.

In the remaining sector of employment—the general services such as transportation, financial, banking, wholesale/retail trade and the forces—progress has been patchy. Substantial groups such as the railways are not modern, and even the efficiency of road transport is reduced greatly by a bad communication system. In other parts



Increased output of office machinery by British firms.

of this third sector, such as wholesale/retail trade and the banks, mechanisation has so far not progressed greatly. We might agree, therefore, that even mechanisation to help hands and muscles has a great future, let alone automation to help men control mechanisation in better fashion.

But the demands on mechanisation are becoming greater. On the factory floor specifications, shapes, tensile strengths, accuracies and timing, are all becoming more difficult and precise. In offices the accountant is facing a more difficult task in presenting his colleagues with more trends and less figures, produced more quickly. Those in charge of research, design, production and sales are conscious of the need to increase customer satisfaction, reducing the widening time-gap between design and sales, and they require better machine power to assist them. This machine power will perform routine control jobs better than humans. Sargrove* refers to " the fallibility of human inspectors under the hypnotic effects of endless repetitive examinations of a mass-produced article, the bulk of which is correct anyway." We already possess many machines which will control quality and quantity better than their man-masters.

Separate groups are becoming increasingly reliant upon each other and progress here will influence progress there. For instance, vast sums are being spent on better locomotives and rolling stock, but recent accidents have underlined the need for other sorts of mechanisation to provide better control. The trends towards retail self-service and the recent controversies in Covent Garden and Smithfield markets point the way to great changes in the wholesale/retail system and it is safe to assume that machine power will greatly increase in this area of employment, perhaps extending into many other supporting industries.

" Service to the customer," that desirable but often unachieved objective must receive greater attention in a future period of greater world competition and higher living standards. It will be achieved more rapidly by bringing machine power to the aid of many. We shall extend the use of self-service vending machines, of machines to book accommodation and tickets thereby reducing waiting time and queues. We shall certainly see much greater mechanisation applied to the home, in a form which will take advantage of the new machine developments elsewhere.

All of this adds up to a formidable increase of machine power and—equally important—a great change in the habits, outlooks and skills of men. We shall have more power to control, and every engineer knows that more power usually increases the relative importance of the means of controlling it. When more machine power is applied to and by wider groups of people the difficulties increase greatly, as much in the reactions of those newly affected as in the technical consideration. It is not by accident that an important plank in the platform of the newly created U.S. union group of C.I.O.-A.F.L. is the unionisation of the white-collar workers, who will increasingly be subject to the impact of the machine. Let us hope that the wider extension of machines in the Second Industrial Revolution will not repeat some of the errors of the First.

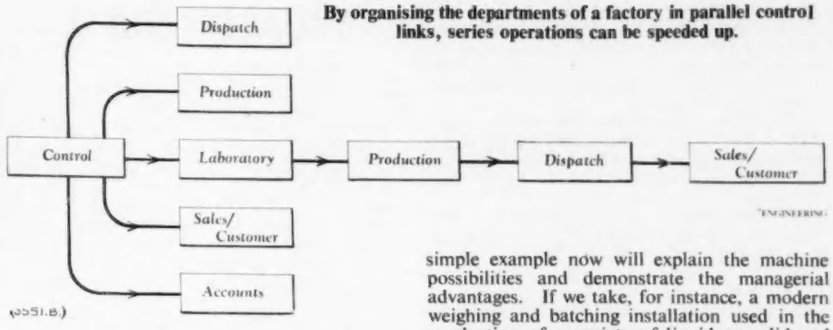
Summing up, the more important ways in which machines will affect man-control seem to be:—

(1) A great extension of machine power to expand man's power.

(2) In particular, a significant extension of machine power into those sectors of the working population where, so far, machine power has not yet been greatly applied.

(3) New demands on future machines to provide those more difficult and precise tasks required by companies and customers which men cannot or should not be called upon to provide.

(4) A considerable re-adjustment of outlook and job, calling for the need to educate by every modern technique that larger number likely to be affected by the wider use of machine power to help men.



By organising the departments of a factory in parallel control links, series operations can be speeded up.

MACHINE CONTROL

Can mechanisation rise to this greater occasion —can the machine assist man to control men better; can the machine help to control *other* machines better ?

Mechanisation is a reasonably understood process and in one form or another has progressively intensified its application over the whole period of the First Industrial Revolution. This will continue, not only in existing sectors but, as I said earlier, it will extend its application into new sectors.

The emphasis in recent years has been on " flow," on keeping things moving continuously through departments. Conveyors and other forms of materials handling have progressed greatly, linking machines and processes together. The automobile factory transfer-line and the modern refinery are logical developments of this trend and it is easy to see that the concept of flow is not realised unless we assume greater control over many variables. Delays and disorganisations likely to be produced by broken or blunt tools, machine breakdowns, temperature changes, dimensional or other quality errors, design or specification changes, must somehow be minimised, and the obvious step is to ensure that variables of this nature are signalled to the machine controller for prompt action or, better still, the machines can be designed to correct these variables either immediately they happen or when there is a tendency or necessity for them to happen. The machines become " conscious " and take over some of man's own control tasks.

Few examples exist where such a degree of machine control is present, at least in the refined sense of anticipating a variation or difficulty and taking steps to avoid it. Present developments ensure that much progress will be made, if only for the reasons that (*a*) this new machine control relieves skilled manpower of some of its load and (*b*) it considerably improves quality and/or quantity control of product.

A logical extension of this controlled-flow concept is to link departments together as well as machines. This will be discussed again shortly as a communication problem, but a simple example now will explain the machine possibilities and demonstrate the managerial advantages. If we take, for instance, a modern weighing and batching installation used in the production of a variety of liquid or solid end products, we may find the control panel in the laboratory, the weighing and handling equipment in one or more factory departments, and statistics being continuously recorded in the accounts and stores departments. An electronic computer such as LEO becomes really effective if it is machine-linked to other departments—and often other factories, offices or shops over a wide geographical area (see diagram above).

We may summarise this section by saying that the more important demands on machine control are likely to be:—

(1) A greater desire to achieve flow—a continuous movement from start to finish.

(2) From this, the necessity to control variables such as quantity, quality, design and specification changes, by providing the machines with anticipatory, self-adjusting devices.

(3) An improvement in managerial and statistical control by linking machine groups to other groups which may be located in separate departments, offices, or factories.

COMMUNICATION CONTROL

It is fashionable to-day for managers to talk about the necessity for " good communications." They are usually thinking solely about linking men to men, senior managers to foremen or shop stewards. The essence of control in the wider sense of this article is that communications between men and machines, and machines and other machines, are equally vital as a direct contribution to better management. Let us briefly review the three categories.

(*a*) *Men to Men.*—In a typical industrial company good communications between all is becoming more difficult and more necessary. Every extension of centralised authority, of union authority, of the number of specialists employed makes it harder to keep all informed and united in achieving a known common goal. Every increase in competition, inflation, complexity or diversification of product makes communication more necessary. These are the problems which the following two categories must help to solve.

(*b*) *Men and Machines.*—A manager who cannot, for various reasons, make physical contact with other men, may increasingly bring the machine to the aid of both parties. If a machine will allow him to reduce tiring and unnecessary travel, to reduce the paper weight on his desk, to spend more time on real control, instead of brain wasting routine, a major gain is achieved. These requirements can be significantly helped by the tools of automation and a great opportunity exists for managers and machine designers to " communicate " in achieving this task. The ability to see and be seen remotely, to prepare and receive more significant control statistics, to manage by exception rather than by routine, to plan ahead with a better and quicker control over the many variables which both men, materials and the future possess—these are great advantages.

(*c*) *Machines and Machines.*—I have already briefly discussed communications between machines and machines. The flow concept will develop this trend, and once again the tools of automation are becoming available for this greater service. They will increasingly be applied with, I hope, the thought continually in mind that if better communications between

* Paper at 1955 Margate Conference; "Automatic Inspection—The Anatomy of Conscious Machines," by A. Sargrove and Peter Huggins.

men and machines and machines and machines do not result in better understanding between men and men, then we shall, indeed, have lost more than gained.

Summing up, the important demands on communications will be :—

(1) The need to achieve, in every group, a widely understood and accepted common goal and the means to communicate rapidly any variations in performances, standards and objectives.

(2) The need to reduce managerial load wherever possible by using machine power to take over routine, wasteful and tiring tasks.

(3) The necessity to develop continuous communication between machines and machines, locally or remotely, so that continuous and rapid flow of products and control information is achieved and maintained.

PRECISION CONTROL

Many managers show a lack of precision in their tasks. They approve vague questionnaires, set loose targets and put up with loose results. One popular management policy (in theory at least) is indeed to avoid giving precise tasks, but rather to delegate authority by illustrating broadly what is wanted, thereafter expecting subordinates to put precision and punch into the execution. In practice the subordinates often carry the imprecision downwards.

At the machine end of the scale we are, however, demanding ever greater precision. A new specification from the design office or laboratory requires tighter limits in order to reach the desirable performance: the production equipment must be more precise to attain and *maintain* consistent results.

How can we reconcile man and machine? We should first admit that precision is not antagonistic to good management; in fact, the contrary holds. Managers do really require more precise control information to assist decision. An American top executive recently said that he wanted a screen in his office on which at any time he could portray the problems of his company six months ahead. Someone else said recently that he would like to be able to buy next Thursday's newspaper to-day! What each wanted was a more precise forecast, a more reliable crystal ball into which is fed significant statistics of past and present in order to portray future trends.

But to get the best answers you must ask the right questions, and an ability to state your requirements with precision is absolutely necessary if you want to control well. The use of computers and similar machines will be effective only if we know what we want and can interpret it to those who control the new machine-power.

Someone once said "Show me a factory whose products are consistent and I will show you a well-organised firm." Consistency and precision are stable companions, and if we want more the consistent results that better forecasting should bring, we must have more precision in minds and machines. Fortunately, the developments in machine-power are encouraging our minds to rise to the occasion.

CONCLUSION

Here then is a brief survey of control power. I have tried to prove that it is compounded of three sectors—men, men and machines, and machines. Its most important manifestation to-day is in the form of managerial control which must effectively integrate these separate but related sectors and provide a working unit where all are harmonious. To control men more effectively we must inevitably turn towards the new machine power for greater assistance, and fortunately much of what is new can be of great help, as long as we realise that ultimate benefit must accrue to man's estate. Let all who are interested in more mechanisation, applied to new groups, using the new tools of automation, continue to remind themselves that every design, plan or project should answer positively the questions: Will this enable managers to manage better, and will it help to increase man's standard of life?

Weekly Survey

Cover Picture: *Vibrographs, such as that portrayed during the final stages of assembly, have many uses in the recording of linear and torsional vibrations. They have been widely employed for such measurements in machines, buildings and ships and even for studying earth movements produced by quarry blasting. The instrument shown produces an immediate record by purely mechanical means, the record being subsequently enlarged optically for examination. A permanent record is valuable, as the form of the waves often yields information as to the sources of complex vibrations.*

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Iron, Steel and Fuel

It is traditional to think of industrial development on any scale being determined by the trinity—coal, iron and steel. The point was emphasised again last week, this time by the British Iron and Steel Federation in the latest issue of *Steel Review*. Although marked economies have been made in the use of coking coal for the production of pig iron in blast furnaces, the *Review* predicts that increased production of steel in the 1960's could be jeopardised unless users outside the steel industry at present burning coke for unessential purposes convert to other forms of fuel.

In addition, there is a hint of a possible danger of excess steel capacity in the future if the growth of overall industrial production is hampered by shortage of fuel. Since the bulk of any future increase in steel production will be based on pig iron (about 60 tons of pig iron for every 100 tons of steel), it will be essential that plentiful supplies of coke are forthcoming for the blast furnaces. Last year, blast furnaces consumed about 20 million tons of coke in coal equivalent, and by 1960, assuming a reasonable rate of development, this consumption could probably approach 30 million tons per annum.

Considerable progress has been made by the iron and steel industry with the efficiency of coke consumption. While production of pig iron and ferro-alloys has risen by 34 per cent. over the last seven years, the coal equivalent of coke charged to blast furnaces has risen by only 23 per cent. Much of this gain has been achieved by increased sintering of ores before they are put into the furnace. Furnace trials using 100 per cent. sinter have, it is claimed, shown coke consumption rates approaching the theoretical minimum. The proportion of sinter to total ore consumption is said to have doubled to some 34 per cent. since 1946.

The steel industry as a whole has undoubtedly economised on coal in the last few years. By using alternative fuels, such as oil, creosote, pitch, electricity and coke-oven gas, output of steel has been raised by 33 per cent. since 1949 while fuel consumption has gone up only 14 per cent., coal consumption going up by as little as 8 per cent. Meanwhile fuel-oil consumption has risen by 105 per cent. in the same period, and the intake of tar has expanded by 413 per cent.

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Conditional Productivity

Enough has been said on the need to raise productivity as the solution for many if not all of our economic ills. While it is considered relatively easy for large companies to raise productivity through the funds available from their own resources, small ones often find it difficult to do so on narrow profit margins. Since, as Mr. Peter Ford, chairman of the Institute of Export, pointed out last week, half the nation's labour force is in companies employing less than 500, it is obviously of primary importance for small companies to be given every opportunity to expand their productivity.

For this reason alone, the Conditional Aid scheme announced under the aegis of the Mutual Security and Economic Co-operation Aid plans in 1953 must be considered a success. Under this scheme, grants totalling 100 million dols. were given to European countries on condition that the equivalent in local currency was spent towards increasing productivity, raising efficiency and stimulating competition. The British share totalling £3·2 million has now been spent and the British Productivity Council, the British Institute of Management and the Department of Scientific and Industrial Research have been able to grant funds for such developments as implementing work study, statistical and accounting control, office mechanisation and similar projects over a wide field of industry. Funds alloted to small concerns have been particularly advantageous. For example, a light forging company starting on new lines and new markets was helped to draw up an adequate costing scheme; a small woodworking company was enabled to engage a firm of industrial consultants to implement work study which raised sales by 30 per cent. using the same labour force, while labour costs fell and earnings rose.

Of the larger bodies benefiting, the Association of Jute Spinners and Manufacturers introduced a system of work study with the help of a grant of £10,000 which has had the effect of raising productivity in a marked degree. The North Eastern Industrial and Development Association was enabled to widen the scope of its activities, and many more schemes were got under way to raise industrial and agricultural productivity. It will be interesting to see exactly what the avowed "pump-priming" effects of these funds would have been now that Conditional Aid has come to an end. Nobody can dispute its usefulness so far.

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Ceramics for Cutting Steel

Progress in the use of ceramic-tipped tools continues to be reported from the United States and from Russia. As might be expected, there is more information from the United States than from the Soviet Union on the subject. There seems to be no doubt that measured purely on a conventional basis, that is in surface feet cut per minute, the new ceramic tips now offer a performance well beyond the range of tungsten-carbide or special-steel tipped tools.

There is a growing opinion, which may be somewhat optimistic, that ceramics will be adopted for this purpose much more quickly than, say, was the case with tungsten-carbide tips, owing to the growth of automation and the consequent importance of cutting down the time taken by tool replacements. Ceramics have the attraction of requiring none of the currently scarce materials, such as tungsten, tantalum, cobalt and nickel. Among their possible lines of development there may be important uses for ceramics in machining the outer skin from sand castings, machining hardened steels and sintered parts and reducing tool wear on high-temperature materials in such uses as jet engines.

There are bound to be a large number of problems to be solved, however, before a ceramic material with a very high cutting performance can be widely applied. In addition to the brittleness of the ceramic, which makes it necessary to have special steel holders, special planning of production control is required to handle the high speeds which can be achieved. Behind this, however, lies the need for accumulated experience on the application of ceramic cutting techniques to the design of machine tools and the tendency that may follow later towards higher prices of the machines themselves. It is only comparatively recently that the great advantages of tungsten-carbide tools have been accepted on a wide scale in this country and it will probably be some time before ceramic tips are in general use either in this country or elsewhere.

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Rolling Stock Builders

The difficulties which faced British manufacturers of railway rolling stock in meeting quickly the huge backlog of demand which had accumu-

lated during the war got them an undeservedly bad name. This bad name was then used rather unscrupulously by the administrations of some railways overseas to divert attention from their own shortcomings. It is, for example, doubtful whether shortage of rolling stock and delays in delivery by British manufacturers have for some time been a major adverse influence affecting the operation of overseas railways.

Partly owing to the steady growth of manufacturing capacity in former markets, British wagon manufacturers are, in fact, now glad to get orders and can offer both competitive prices and good delivery dates. The recent order for 2,300 general-purpose wagons worth £2·3 million for the New Zealand Railways is therefore welcome. The original order was for 1,550 wagons placed with the Metropolitan-Cammell Carriage and Wagon Company, but goods traffic in New Zealand increased in 1955 by 7·26 per cent. and it was accordingly decided to increase the order for wagons. The recipient of the increased order is not yet known.

Meanwhile the results of the main wagon builders continue satisfactory. Charles Roberts and Company reported last autumn that the supply of steel had been very much better during the past year, and with the contraction of the motor vehicle and light engineering industries due to the credit squeeze this trend has probably continued, though it may not have affected the shortage of heavy sections which was noticeable last year. The hire-purchase activities of the British Wagon Company, who reported record earnings last week, now of course range into a variety of other fields, and it seems possible that motor vehicles (especially commercial vehicles), agricultural machinery and industrial equipment account for a major part of their turnover, so that the company's name may now be rather out of line with its business.

The outlook in the home market for wagon builders is probably rather less rosy because the average intake by the British Transport Commission over the period of the 15 year modernisation plan (about 20,000 per annum) is likely to be smaller than has been the case in recent years. This has always been an industry with a big dependence on exports.

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Expansion at Sheffield

The Iron and Steel Board has given its approval for the first stage of the development of a site at Tinsley Park, Sheffield, acquired in 1954, by English Steel Corporation, Limited, to provide an adequate area for the development of heavy industries. A geological survey of the area is in progress and site levelling is scheduled to commence towards the end of the present year.

Open-hearth melting furnaces and heavy forging plant will be erected and facilities made available for the production of steel castings heavier than those now manufactured at the Grimesthorpe Works of the Corporation. The cost of the scheme is estimated to be £15 million, but expenditure in the next two years will not be great as the specialised nature of the plant involves considerable design work and a long period of manufacture. An Industrial Development Certificate, however, has been granted by the Board of Trade for the erection, in one corner of the site, of a new works to house part of the spring plant now in old premises at the Grimesthorpe Works. In the Tinsley Park Works a completely new layout for the manufacture of laminated and coil springs will be installed to meet the demands of the motor-car industry.

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New Records for Office Machinery

To judge from figures released for 1955, the credit squeeze had little effect on makers of office machinery up to the end of the year. There is little indication that the deflationary policy has had much effect even in the early weeks of 1956. The output of office machinery went up by 10 per cent last year to almost £39 million—thus maintaining an unbroken steep upward movement for a full decade. All sections of the industry established new records.

Behind this spectacular advance lies the chronically high level of clerical salaries and the difficulty of attracting young recruits into clerical work at all. In addition, techniques of market surveying, business forecasting, budgetry control and cost analysis are being increasingly developed. In turn this creates a constant demand for accurate figures and calculations at high speed. The historical records of the company for yesterday are wanted in the board room and by top management to provide the basis for decisions affecting the company's results tomorrow. At the same time there is a tendency for companies to become grouped in larger and more complex organisations which maintain their efficiency by the large capital sums they command, and the accuracy and skill with which a vast amount of collated data is presented before top level management for making decisions. In this world, the computer, the punched-card system and the multi-column accounting machine find their most successful applications.

It is noticeable, however, that the industry as a whole continues to make vigorous and on the whole successful attempts to adapt its complicated accounting and statistical equipment to the needs of small companies. Meanwhile the race to break records is not the monopoly of the accounting side of the industry. Hardly less impressive has been the performance of the typewriter and office furniture industries.

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U.S. Stockpile Report

In the latest half-yearly stockpile report by the Office of Defence Mobilisation to Congress, it is announced that the United States has completed the minimum stockpile requirements of 38 strategic materials. The list covers a very wide range of raw materials, many of which the sterling area is vitally concerned with and there are only two well-known materials missing. These are wool and jute. The latter does not appear in the list at all and wool is one of the materials where stockpiling is to be confined to transfers from U.S. Government surpluses.

The objective for the stockpile at the end of 1955 was 6,900 million dols., of which 5,300 million dols. was actually in stock or covered by outstanding orders at that time. It seems likely that the transfers and exchanges which have been going on lately will be sufficient to cover the stockpile requirements even of such scarce metals as nickel. In addition to the ordinary stockpile programme there is a long-term programme which was put at 4,300 million dols. last December, but this programme is to a large extent a device for supporting U.S. mineral industries. It is thought that the present appropriations of stockpiling funds will be sufficient to meet all outstanding needs, which should now decrease fairly rapidly from 1956.

Under the original 1946 Act setting up the stockpiling organisation, one of the activities was to be the development of new resources and substitutes for existing materials. The latest report gives some examples of the successful development of new products now actually reducing the demand for materials which were critically short a few years ago. There have also been improvements in the techniques of mining. Further, smelting ore-bodies which until recently were sub-marginal have been found possible of treatment. Thus the stockpiling activities of the United States over the last decade have had a technological as well as a market significance.

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Atoms and the Middle East

When the Economic Council of the Baghdad Pact held its first meeting earlier this month at Teheren, there was a welcome indication that the members of the Pact had no wish to confine their deliberations and pronouncements to broad generalisations. A flavour of innovation was given to the proceedings by the announcement at the end of the first session that the United Kingdom was prepared to offer £250,000 in addition to sums already earmarked for an atomic energy training centre in Baghdad, over a period of five years. This money would be used in those fields which the United Kingdom could most usefully make a contribution; possibly the bulk of the funds will go to finance the work of British advisory specialists in the Middle East and for fellowships in the United Kingdom.

The economic work to be undertaken under the Baghdad pact has the initial advantage of the experience which has been gained under the Colombo Plan. Three points have become clear to members of the Colombo organisation as time has progressed. They have come to accept the fact that the development of Asian territories depends on three factors. These are the provision of industrial equipment, the provision and training of technical and management personnel and, thirdly, the willingness of all territories to see certain problems as area investigations covering more than one country. Under this last heading has come an increased willingness for members of the Colombo organisation to co-operate among themselves. It has been noticeable at Teheran that Pakistan has offered technical assistance in setting up village aid centres to raise agricultural production and has also offered to accept trainees. If those working under the Baghdad pact can stimulate this interest in mutual help among members, as has occurred under the Colombo Plan and on the lines which a small but devoted group of British officials have worked on through the years in the Middle East, much will be achieved towards welding the members of the pact into an increasing prosperous whole. This kind of approach is less spectacular but possibly more enduring in its results than the development work undertaken on strictly national lines out of the large oil revenues which certain of the Middle East states are now enjoying.

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Opportunities in Western Nigeria

The Prime Minister of Western Nigeria is on a world tour to invite investors and manufacturers to participate in the economic development of his country. On his list of calls are the United Kingdom, Germany, Italy, Japan, Canada and the United States. While in London the Prime Minister made it quite clear that his Government were determined to secure quick industrial gains and to raise the standard of living of their people: "We Nigerians are in a hurry. We realise with poignant keenness that we have been left far behind in the race for economic and social progress. We are naturally anxious to shorten the gap in the shortest time possible. Because of the close link that exists between our two countries we look up to the United Kingdom more than to any other nation for help in attaining this objective." They need the technical assistance of industrialised countries and mean to obtain it. They are particularly interested in getting consultants, survey specialists and manufacturers to come to Nigeria, and in return they are prepared to create "an atmosphere for such capital and technique to stay."

Western Nigeria has a population of 6½ million. It is the main cocoa-producing area in Nigeria and also produces rubber, oil-palm produce, timber and a variety of other agricultural products. Its mineral resources are still largely unknown but will be the subject of intensive investigation in the near future. Recently the Government of the region drew up a five-year development programme which involved the expenditure of about £104 million, £98 million of which will be found from local resources. The bulk of the expenditure will be in the development of primary and technical education. The Prime Minister repeatedly stated

that Nigerians are hard workers and quick to learn and absorb new techniques. Of the £104 million scheduled under the plan, over £35 million will be spent on education. The next biggest item is agricultural development, and the setting up of a production board and a finance corporation for the development of agriculture and forestry. This will account for some £20 million. By contrast, expenditure on industries and trade will be small—just over £7 million. Other items of importance are public works, publich ealth and the development, of water supplies.

Nothing very spectacular is taking place in Western Nigeria but the Government's determination to speed up economic development is unlikely to result in their representatives going back empty-handed from their tour of the six major industrial countries which they plan to visit. British industrialists would be well advised to see for themselves what can be done in one of the few territories in Africa where the relations with the white man are cordial.

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Much is Expected of the Railways

The Minister of Transport has reached an odd decision in rejecting the advice of the Transport Tribunal and authorising the British Transport Commission to raise their charges by less than they require. Mr. Watkinson and the Commission agree that the railway charges will be raised to yield approximately £20 million in a full year, compared to the £37 million—an all-round increase of some 10 per cent.—recommended by the Tribunal. This is an interim decision, to be reviewed in six months time. It is justified on the grounds that Mr. Watkinson took count " of the signs which exist that renewed and strenuous efforts will improve the financial outlook on the railways through more efficient working arising from better relations in the industry." Yet there are signs also that the British Transport Commission are apprehensive lest higher charges should mean less traffic at a time when heavy capital expenditure is being incurred on re-equipment. The decision to reduce the projected increase in revenue from passenger fares from £5·7 million to £1 million strongly suggests that this might be so.

The Transport Tribunal argue that the financial position of the Commission, due to the railways' mounting deficit, is just too awful to contemplate. They estimate that British Railways would, if rates were not increased, fail to pay their way by approximately £55½ million in the coming year. In 1955, their deficit was approximately £38 million. The Tribunal say that the 10 per cent. increase they recommend " allows for some improvements in efficiency " that could not possibly do more than reduce the gap of £18 million " which would still separate the Commission from solvency even if all the measures proposed by them were put into effect." Mr. Watkinson is, in fact, proposing to pay the railways a subsidy, probably to help them along with their modernisation programme. Yet quite recently the Chancellor of the Exchequer, Mr. Macmillan, pleaded the need to combat inflation as his justification to cut the bread subsidy. Perhaps this confused picture of divergent policies reflects confusion within the Government. The " keep-prices-down campaign "—also a dis-inflationary weapon according to some—has supporters in high places. Mr. Watkinson may have succeeded in pleasing three at a cost of upsetting one. But we fear that the best arguments are those of the Railway Tribunal and that it would have been time enough to reduce charges when savings in operating costs through greater efficiency gave British Railways something to spare.

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Research on Water Supplies

The Water Research Association is the latest of the 40 or more research associations which receive financial support from the Department of Scientific and Industrial Research. It is estimated that the water undertakings are losing £5 million per year as a consequence of corrosion and £1 million through leakage.

Study of the many problems associated with water supply has by no means been neglected in the past. Apart from work done by the chemists and engineers of the larger undertakings, the Institution of Water Engineers has initiatied research, but lack of funds has prevented the development envisaged and desired. The Water Pollution Research Laboratory of the D.S.I.R. has also done some work, particularly in connection with the corrosion of fittings, but work of this type lies outside the proper sphere of the laboratory; its business is with polluted water, not with water supplies. It is due to the initiative of the British Waterworks Association and the Institution of Water Engineers that the Water Research Association has been formed.

It has frequently been pointed out by research bodies that so many *ad hoc* problems present themselves for consideration that fundamental research is hampered or delayed. The new association has, however, been able to start work in both fields. Researches in hand are concerned with the detection of leaks in water mains and the use of plastics for service pipes and, in the fundamental sphere, on the properties of filter media. The two immediately practical problems are interconnected. The use of non-metallic pipes may require the detection of leaks by other than acoustic methods. Electronic devices are available for overcoming lack of sensitivity in leak-detection instruments, but much remains to be done. Research is being directed towards finding a method of distinguishing between the sounds of a leak and extraneous noise and towards the development of a truly directional detector.

At the present time, the membership of the Association comprises undertakings which control more than half of the water supplies of Great Britain and Northern Ireland. The headquarters of the Association are at 18 Lingfield-lane, Redhill, Surrey.

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Buying Design Ideas

News that the British Motor Corporation has bought the prototype of a new E.R.A. sports saloon does not necessarily mean that any such car will be put into production, but it is evidence of the quickening tempo of technical investigation in the industry. It is understood that the car is a low-built streamlined saloon, designed to use an engine of 1½–2 litres capacity, and it contains a number of advanced design features.

This is not the first time car manufacturers have bought new designs from outside to study specific problems. It happens both here and on the Continent. Years ago, when designing the A30, Austin bought a prototype of an air-cooled twin-cylinder front-wheel-drive car but subsequently rejected these design features. A previous E.R.A. prototype, with tubular chassis, rear-mounted gearbox, and a De Dion axle of exceptionally light and simple design, was bought by Bristol, who used it as the basis of their team cars for Le Mans, but do not seem to have made any use of it in the development of their production models.

E.R.A. Limited, having been acquired by the group which controls the Solex and Zenith carburetter enterprises, will apparently continue as an independent research and development organisation serving the motor industry. Those like Sir Harry Ricardo's and Harry Weslake's in England, and that of the Porsches, father and son, in Germany, have already rendered notable services to the industry, and there should be no shortage of work now that competition is becoming keener.

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International Conference on Metal Fatigue

While the fatigue of metals and its measurement have been studied for many years, the introduction of new alloys and other materials together with new methods of treatment and of assembly to meet the increasingly arduous conditions encountered in modern high-speed machines, has led to the adoption of new techniques and the revision of old conceptions in fatigue testing. Fatigue problems, in one form or another, are encountered in all branches of engineering and applied science and this lends interest to, and adds to the importance of, the forthcoming International Conference on the Fatigue of Metals. It is sponsored by the Institution of Mechanical Engineers in co-operation with the American Society of Mechanical Engineers, and is to be held in London from September 10 to 14 and in New York from November 28 to 30. According to a detailed programme which has been issued recently by the Institution of Mechanical Engineers, the 70 papers to be presented will be dealt with in 10 sessions. The papers will be presented in abstract by reporters, about 30 minutes being devoted to this in each session, thus allowing some two to two and a half hours for discussion and replies.

After the opening of the Conference by the President, Mr. T. A. Crowe, on the morning of September 10, Dr. H. J. Gough, F.R.S., will give an introductory address. Thereafter the sessions will deal with stress distribution; the influence of temperature, frequency and environment on fatigue; metallurgical aspects of fatigue; basic studies; and the engineering and industrial significance of fatigue. A feature of the conference is that the charges to be made are most reasonable. In addition to a registration fee of one guinea, advance copies of the 70 papers will be available to registered members of the conference on payment of a further £1.

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A Century of Water Turbine Manufacture

The little country foundry and engineering shop of the Nineteenth Century was generally prepared to take on almost any kind of work to which its equipment and the skill of its men could be adapted. Often enough the equipment was anything but suitable, but the men made the best of it, and the job was done satisfactorily. The simplest reward for adaptability was continued existence; sometimes it was prosperity. Occasionally the receipt of an order for a special piece of machinery could have a far-reaching effect on the business. Such an order was the basis on which the business of Gilbert Gilkes and Gordon, Limited, Kendal, Westmorland, was founded.

The firm, who will celebrate their centenary in June of this year, originated as a small foundry started in about 1850, by two brothers named Williamson. Taking over some old warehouses at Kendal, the brothers set up in business as makers of agricultural machinery and small steam engines, and this work, for the local market, occupied them for a year or two. It was in 1856 that the Williamsons received an order for a prototype 5 h.p. Vortex turbine designed by Professor James Thompson, brother of Lord Kelvin. The drawings, made by Professor Thompson himself, are still preserved by the Kendal firm. It is from the receipt of this order that the firm dates its foundation, and it is in the unusual position of being able to say that not only do the drawings of its first machine still exist, but that the machine itself remains in working order at the farm where it was installed, and is, in fact, run from time to time.

The Williamsons were granted the manufacturing rights of the Vortex turbine and began to specialise in its production, at first for the local market but soon for export as well, the first machine to be shipped abroad being number 120, a 22 h.p. turbine which went to Australia in about 1860. When the Williamson brothers sold the business to Gilbert Gilkes, of Middlesbrough, in 1881, the manufacture of water turbines was well established, and the product was well known at home and abroad. Gilkes gave the firm his own name, calling it Gilbert Gilkes and

Company, and extended the range of manufactures to include Pelton wheels and other types of turbine.

Towards the end of the Nineteenth Century there were further developments, water turbines becoming increasingly popular for driving electric generators. In 1896, 14 out of 70 important turbine installations were for this purpose, and a considerable amount of pioneer work was done in this field by the Kendal firm. Greenside Lead Mine, Westmorland, for example, which installed the first underground electric mine haulage in Great Britain, derived its power from a Gilkes water turbine supplied in 1893.

In 1928, the firm acquired the water power business of James Gordon and Company, Limited, of London, and transferred it to Kendal. In keeping with the needs of the time, the company have brought their works fully up to date, and have developed their own research organisation, for while they are justifiably proud of their 100 years of business they are fully conscious of the fact that no firm can exist on history alone. It could well be that the water turbine will become of increasing importance in this country, for although we have but little water power compared with some parts of the world, by no means all of it is used. In these days of high fuel costs and demands for clean air, it might be as well to remember that, as Mr. Paul N. Wilson, chairman of the company, says in his booklet on the history of water power entitled *Watermills: An Introduction*, " . . . the water tumbling over the weir would happily turn a wheel and work quietly and inoffensively day and night to produce its quota of power without noise, smoke or smell."

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Copperbelt Technical Foundation

Considerable progress has been made with the plan to establish the Copperbelt Technical Foundation which is to provide technical training for young Europeans in Northern Rhodesia. This venture has been made possible by the contribution of a joint sum of £400,000 by the copper mining companies of the area.

Sites for college buildings have been considered in three centres—Kitwe, Luanshya and Mufulira—and, in the case of Kitwe, drawings of the Foundation's headquarters there have been prepared. A further step has also been taken with the appointment of Mr. Eric Howell, at present principal of the Pietermaritzburg Technical College, as principal of the Foundation. It is expected that Mr. Howell will take up his duties on July 1, 1956.

The selection of his staff and the planning of the curricula will be among his first tasks, and for this he will be able to draw on 30 years' teaching experience in South Africa, including being an examiner and moderator in various engineering subjects for the education department of the Union. Prior to emigrating he had been chief designer to a well-known Liverpool manufacturing company and had had part-time teaching experience as a lecturer in electrical design at the Bradford Technical College, after previously graduating from Bristol University in 1922. Doubtless the advent of the Kariba project and other hydro-electric power schemes within areas adjacent to the Copperbelt influenced the selection of an electrical engineer as the Foundation's first principal, an appointment which attracted more than 100 applications from many parts of the world.

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Manufacturer and Distributor

How to maintain good relations between manufacturers and distributors was the main subject considered by Mr. J. Orwig Jones, sales manager of Edward G. Herbert, Limited, in a speech at the Council luncheon of the Association of Engineering Distributors. He stressed that manufacturers should deal only with reputable merchants and that these formed the best sales men for the ordinary " bread-and-butter " lines of tools. One of the chief points of friction was the vexed question of price maintenance.

Price cutting was largely dependent on the integrity of the merchant concerned. Carriage charges should be included in the price quoted, otherwise the prices would cease to be standard. His own firm used an average value when making direct quotations. Any cash discounts made by the manufacturer should be passed on to the customer and for this purpose manufacturers should quote on a monthly account. Another point in which the distributor could be of great assistance to the manufacturer was in servicing the machines during the guarantee period. Much wasted labour could be saved if the merchant sent a comprehensive report of the trouble and, even more, if he had his own specialist to follow up the customer's requirements. Most manufactuers were only too glad to train such specialist servicemen on the particular machines concerned. Where books of instructions were issued with a machine it was the duty of the merchant to see that they were sent on to the customer. The Machine Tool Manufacturers' Association, he said, while deploring price cutting, did not feel that they should make any organised move in the matter. The main job of the merchant was to sell service, for machines could be purchased from many dealers but service often determined the final choice. It was up to the manufacturers only to deal with men whom they were sure would not undercut the list price.

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Fencing Abrasive Wheels

An abrasive wheel securely fenced according to the legal interpretation of the Factories Acts is completely enclosed, and is therefore unusable in the normal manner. To remove this anomaly the Minister of Labour proposes to make new Special Regulations for fencing such wheels. A draft of the proposed statutory instrument, entitled " The Fencing of Abrasive Wheels Special Regulations, 1956," has been issued, and copies are obtainable from H.M. Stationery Office, price 2*d*.

The proposed regulations specify, *inter alia*, that there should be provided for every grinding wheel " . . . a guard properly adjusted so as to enclose the whole of the wheel except such part as is necessarily exposed for the purpose of any work being done . . . " The guard will have to be kept in place at all times when the wheel is in motion or in use. Also covered by the regulations are the design and method of securing the guard and work-rests, and of the duties of the person using the wheel, though provision is made for exemptions in special cases under the authority of the Chief Inspector of Factories.

Hitherto, factory inspectors, because of the impossible requirements of the law, have been able to do little or nothing about grinding wheels unless they were patently dangerous. The proposed regulations are essentially reasonable, but there are quite a few wheels which do not comply with them and it will not be surprising if the inspectors tighten up their attitude to poor fencing just as soon as they have some practical regulations to enforce.

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Electrical Development Conference

The annual conference of the British Electrical Development Association, which is organised " for the free discussion of sales management problems among representatives of the electricity supply industry from all parts of the country," was held in London from April 10 to 13. The papers presented covered a wide variety of subjects, including the better lighting of commercial and industrial buildings by illuminated ceilings; organising to meet competition; electricity and smokeless zones; planning the service centre; and automation.

From the technical point of view the high-light of the conference was Mr. J. Eccles's opening address on developments in generation. Since 1950, he pointed out, larger machines operating at more advanced steam conditions had been included in the generating plant programmes—first 100 MW units operating at 1,500 lb. per square inch and 1,050 deg. F., and then 120 MW sets using re-heat. Orders had now been placed for 200 MW sets to operate at 2,350 lb. per square inch and 1,050 deg. F., reheating to 1,000 deg. F. These would generate 50 per cent. more electricity per ton of coal than the present average and, in 1962, 70 per cent. of the new machines commissioned would be of this capacity or higher.

Turning to the question of fuel supplies, Mr. Eccles said that our hopes for the future rested upon nuclear power. Describing the graphite-moderated gas-cooled reactors which are being installed at Calder Hall, he mentioned that a possible development would be the use of liquid sodium for cooling. This would enable the coolant temperatures to be substantially increased and thus give better steam conditions. The pressurised water reactor, such as was used in the Nautilus, was also capable of development for power station use. In its modified form—the boiling water reactor—saturated steam could be supplied direct to the turbine, but the process had drawbacks associated with irradiation. The most advanced reactor for power station use was the homogenous type in which fuel was employed in the form of slurry. This enabled fission products to be removed by continuous chemical processing.

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Magnesium in the Modern World

Despite the availability of magnesium-bearing minerals, of which dolomite is the most abundant, by far the largest tonnage of magnesium is to-day extracted from sea water by the Dow Chemical Company at Freeport, Texas, U.S.A., and by the Norsk Hydro Company, at Heroya, Norway. This statement was made by Major C. J. P. Ball, chairman of Magnesium Elektron, Limited, in the course of his presidential address to the Institute of Metals.

The scale of operations is indicated by the fact that the consumption of the metal in the United States reached 65,000 tons in 1955, the highest total so far recorded. In the United States consumption is expected to reach 100,000 tons per annum by 1960, and 384,000 tons by 1975. In this country, the high cost of electric power, which to-day is five times the 1938 figure, makes it impossible to operate, without subsidy, the established electrolytic processes to compete with the prices at which magnesium is available from the United States, Norway and Canada. Intensive efforts, therefore, are being made to find a method of extracting magnesium from the dolomite deposits of the United Kingdom without the use of electric power. Major Ball stated that considerable progress has been made and that it may yet prove possible for this country to have supplies of magnesium from its own dolomite.

Turning to outstanding applications, Major Ball referred to the use of magnesium-alloy castings for aircraft landing wheels and for motor-car and tractor engines. He added that there is an expanding usage of new alloys of magnesium with zirconium in the aircraft industry. Magnesium is being used in steadily increasing quantities for alloying with aluminium as the reducing agent to extract metallic titanium from titatium tetrachloride by the Kroll process. The properties of the metal make it the ideal material to employ as galvanic anodes for the cathodic protection of iron and steel and other corrodible metals. Furthermore, large quantities of thick sheet are being used for heavy-vehicle bodies, and in the printing trades on account of its admirable etching qualities. Equipment suppliers, concluded Major Ball, are becoming " magnesium-minded," and the machine-tool industry is beginning to realise the great advantages that can accrue from the metal's very high machining rates.

DOMESTIC HEATING IN GREAT BRITAIN

SPACE, WATER AND COOKING

By W. F. B. Shaw, B.A. (CANTAB)*

There have been many developments since the war in heating systems for houses and flats. Gas, electricity, oil and solid fuel; space and water heating, cooking—these are the main divisions of the subject, all of which are reviewed in this article. Consideration is also given to district heating and to the heat pump. The subject is of perennial interest but is of special significance now as a conference on domestic heating is being held in London next month.

INTRODUCTION

The term domestic heating is used here in its most general sense, to cover the three-fold service of space-heating, water-heating, and the provision of cooking facilities. It is a subject of considerable complexity, especially as far as the space-heating function is concerned, and there would appear to be two main reasons why this is the case.

The first is that the temperate climate of the British Isles does not impose any over-riding compulsion on the form of heating to be adopted. In very cold climates there is no choice but to heat the whole, or substantially the whole, of the house continuously, and the use of an open type of fire is precluded because of the inordinate amount of cold air which it draws through the house. Here, on the other hand, it is practicable to have almost an infinite range of heating arrangements between the extremes of a simple radiant source in one room, lit only when required, and a system which maintains full physiological comfort throughout the whole house at all times of the day and night. The choice, within this range, is dictated in part by the preference, and in part by the economic circumstances, of the individual.

The second reason is that solid fuel, although representing somewhat over one-half of the total domestic fuel consumption of the country, by no means dominates the picture. Gas and electricity, and to a lesser but growing extent oil, all make their important contributions to the overall pattern. In the case of solid fuel it has been found both simple and convenient to increase the efficiency of fuel utilisation of the traditional open fire by making it perform other functions, such as water-heating, or cooking (or both) at the same time as space-heating, and this factor has led to the development of a wide range of multi-duty appliances.

The pattern of use of the various fuels for domestic purposes, as it existed in 1952, was established in a national survey carried out in that year by the Coal Utilisation Council.[1] This may be taken as substantially representing the position at the present time, except that it takes no account of the increase in use of oil for space and water heating during the last few years. The figures are expressed, in Table I, as the percentage of all households using the particular fuel.

TABLE I.—*Comparative Uses of Solid Fuel, Gas, Electricity and Oil for Domestic Purposes (Per Cent.)*

Fuel	Space heating		Water heating		Cooking
	Main	Ancillary	Winter	Summer	
Solid fuel ..	98	1	47	36	15
Gas	1	2	44	50	72
Electricity ..	1	13	9	14	14
Oil	—	—	—	—	1

(The apparent discrepancy in the case of "Cooking" is caused by some households in the survey reporting two methods of cooking as their "usual" method).

ECONOMIC FACTORS

Four principal factors have to be taken into account in the selection of a heating system, and fuel, for any particular house:—

(*a*) The standard of heating service required.
(*b*) The capital cost.
(*c*) The running cost.
(*d*) Convenience and labour-saving characteristics.

The relative values which must be attached to these four factors vary greatly from case to case. The feature of convenience and labour-saving is one of growing importance, especially among the servantless middle classes of to-day. It accounts for the popularity of more expensive appliances, such as thermostatically controlled and oil-fired boilers, and for the use of the more expensive fuels, gas and electricity, for main heating purposes.

It is not possible to give any substantial guidance in the matter of capital cost. The only figures which would have any real usefulness, especially as regards methods of central heating, would be those which included the cost of installation, and these vary widely according to individual circumstances. Some approximate figures, covering in part the field of the simpler appliances, will be found in the report of the Ridley Committee.[2]

Some estimates can be made of the relative costs of supplying space-heating by different appliances and fuels, though here again there are severe inherent limitations on what is practicable. For one thing, the term "space-heating" is used loosely to connote what is really "the creation of comfort conditions within a space," and this is not just a matter of pouring the right amount of heat into the space. Various physiological factors come into play. It is well-known that a person who is exposed to radiation from a high-temperature source, at above a threshold intensity, is comfortable when the air temperature is several degrees lower than is necessary when the heating is purely by warm air. Consequently one unit of radiant heat has a greater value for the creation of comfort than a unit of convective heat, although they have the same thermal content. It may be shown that this difference in what may be called "comfort value" diminishes as the inside-outside temperature difference decreases, so that it is not possible to apply a simple correction factor for the phenomenon[3]. Again, estimates of running cost depend upon a knowledge of the thermal efficiencies of the appliances or systems. This is a complex subject in itself, but it is sufficient for the present purpose to note that the efficiency depends upon the method of measurement, and that it varies with the load on the appliance.

Within the limitations discussed above, Table II has been prepared to show the cost of delivering one therm of useful heat from various combinations of appliance and fuel. In the case of solid-fuel appliances continuous heating is assumed. To facilitate comparison, and to avoid as far as possible the difficulties involved in dealing with both radiant and convective systems, the systems have been divided into three classes. The first consists of radiant heaters, suitable for the heating of individual rooms. The second and third cover the convective systems, the second those for individual rooms and the third those for partial or full central heating. The basic fuel prices used are, as nearly as possible, those currently obtaining in the London area. Any local variations may be corrected by direct proportionality.

Radiative and convective heating differ in that the former is essentially "personal" heating while the latter is really "space" heating. In a room heated by a high-temperature radiant fire, the occupants can adjust their environment by alteration of their position in relation to the fire. Some measure of comfort is experienced over a limited area as soon as the radiation reaches a threshold level, and the zone of comfort gradually extends in area across the room.

TABLE II.—*Cost of Producing One Useful Therm for Space Heating by Different Systems and Fuels.*

	s.	d.
(*a*) *Radiant Heaters*		
Openable stove (using coal at 146*s.* per ton) ..	1	4
Convector open fire (using coal at 146*s.* per ton) ..	1	6
Improved type open fire (using coke at 163*s.* per ton) ..	1	6
Traditional open fire (using coal at 146*s.* per ton) ..	2	2
Electric fire (using current at 1·1*d.* per kwH) ..	2	9
Convector gas fire (using gas at 1*s.* 10*d.* per therm)	3	0
Ordinary radiant gas fire (using gas at 1*s.* 10*d.* per therm)	3	8
(*b*) *Convector and Background Heaters*		
Closed stove (using coke at 163*s.* per ton)	0	11
Closed stove (using anthracite at 222*s.* per ton) ..	1	1
Oil heater (using paraffin at 2*s.* per gallon)	2	0
Flueless gas heater (using gas at 1*s.* 10*d.* per therm)	2	0
Electric heater (using current at 1·1*d.* per kwH.) ..	2	9
(*c*) *Central Heating Boilers*		
Gravity-feed boiler (using anthracite at 210*s.* per ton)	1	0
Coke-fired sectional boiler (using coke at 163*s.* per ton)	1	2
Oil-fired sectional boiler (using gas oil at 1*s.* 3*d.* per gallon)	1	3
Gas-fired boiler (using gas at 1*s.* 5*d.* per therm) ..	1	10

Convective systems, on the other hand, have no such focal point of comfort; in general, the spaces they serve are either comfortable as a whole or uncomfortable as a whole. They must be operated continuously, since the establishment of a comfortable environment over a whole room from a cold start is clearly a slow operation. The cost per useful therm of heat is consequently a fair basis of comparison between different convective systems. Section (*c*) of Table 2 shows that, for central-heating boilers, there is little to choose between the costs corresponding to the first three methods listed, only gas heating (at the price quoted) being significantly more expensive. For room-heating convective appliances it is seen that solid-fuel systems are definitely the cheapest in running cost.

It is clear, from what was said in the preceding paragraph, that radiative heating is well suited to intermittent and short-period heating in much of the weather experienced in the British Isles, and it is, in fact, widely used in this way. The cost per useful therm, in Section (*a*) of the Table does not, in this case, serve as a complete index of cost, since a steady state is never reached and the various types of appliance have individual characteristics which materially affect the issue. The output of a gas fire is continuously controllable over a wide range, but that of an electric fire only in fairly large discrete steps. The controllability of a solid-fuel fire depends partly on the fire and partly on the handling by the user; in any event, there are periods of warming-up and of cooling-down, in which fuel is consumed, outside the useful period. Overall costs are therefore not susceptible of precise calculation. For short periods, of the order of a few hours, it is quite clear that it is cheaper to use electricity or gas than solid fuel, quite apart from the convenience factor; "a few hours," in this context, probably means about three. For longer periods the advantage in cost clearly lies with solid fuel.

Water-heating presents some additional complications which make it virtually impossible to express its cost on a truly comparative basis, even if dual-purpose appliances like open fires with back boilers are excluded. Methods of water-heating may be divided broadly into "instantaneous" and "storage" categories. In the case of instantaneous heaters the cost is, for all practical purposes, proportional to the demand since the thermal losses are negligible. With storage methods, on the other hand, there is a constant consumption of fuel to make good the losses, which may be small, for example in an electric storage heater, or fairly large as in the case of the simple solid-fuel boiler. Some of these losses, especially those from solid-fuel boilers, appear as space-heating and are therefore not true losses, at least in the winter, so far as the whole house service is concerned. On the basis of 1950 fuel prices Weston[4] concluded, from work in the Building Research Station's experimental houses at Abbots Langley, that water-heating was cheaper by solid fuel than by gas or electricity when the consumption was in excess of 250 gallons per week. On current prices this figure would appear to have risen to the order of 300 gallons per week.

SELECTION OF HEATING SYSTEM

The preceding paragraphs have indicated how very complex the task of selecting a pattern of domestic heating service for a particular set of circumstances can be in this country. It is therefore possible to make only a brief survey of some of the major features.

Firstly, it is desirable to draw a distinction between the problems of modernising the installation in an existing house, and in designing a complete system for a new house. With old houses the only simple procedure is to accept the broad pattern as it exists, and to replace the individual appliances by more modern types designed to give much the same class of service but more efficiently. An old coal-burning stool-bottom grate, for example, may be replaced by a new type of coke-burning open fire, either inset or free-standing, a solid-fuel stove, either closed or openable, an electric fire or a gas fire. Any more radical change than this involves additional difficulties and expense. In particular, the conversion of a house designed for individual appliances to central heating is a major undertaking, even though it may be much simplified by the use of a small-bore forced-circulation system.

With new houses the problem is simpler, albeit the field of available selection is much wider. It cannot be too strongly emphasised that a house should not be built and then equipped with a heating system; house, heating system and fuel storage should be considered and designed as an integral unit.

The first decision to be made is whether to heat

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the whole house from a central source, or only limited parts of it by individual appliances. If the former is decided, then further choices must be made between "full" and "partial" heating, and between heating by warm air and heating by the circulation of hot water through radiators. More details of these systems are given in later sections. Whatever the choice, the pattern must be completed by the selection of cooking and water-heating methods.

If it is decided to use individual appliances, there is an extensive variety of combinations from which to choose, especially when the various multi-duty devices are taken into account. Reference may be made to Chapter 7 of the report of the Egerton Committee[5] where the subject is reviewed in some detail. In particular, eight complete systems of space- and water-heating and cooking are considered. These were chosen as being particularly suitable for small houses, of the order of 800 sq. ft. area, and all give some degree of background heating outside the living room. Estimates of the annual consumptions of the various fuels are given. The post-war work of the Building Research Station on a group of twenty experimental houses at Abbots Langley also affords much useful information about heating systems for houses of the order of 900 sq. ft. area. The systems employed covered a wide range, from pre-war open fires to full central heating. The experiments were carried out with the co-operation of the tenants in such a way that full records were obtained of all fuel consumptions.[6]

Special cases will, of course, arise in which the choice is limited in some directions, or a particular arrangement becomes abnormally favourable. To take a few examples, in country districts neither gas nor electricity may be available, so that the choice is limited to appliances burning solid fuel or oil. In some rural areas electricity is available but not gas. There is still quite an extensive proportion of houses in the country without piped water. Finally, there are places where particularly advantageous tariffs for gas are obtainable, which make this fuel more closely comparable with solid fuel on a running cost basis.

CENTRAL HEATING

The term "central heating" in the domestic context is generally used to connote the distribution of heat throughout a house by the medium of hot water circulated through pipes and local means of heat emission. Domestic heating by means of warm air disseminated from a central source is of comparatively recent development in this country, although it has been used extensively in the U.S.A. for many years, and it has become the custom to refer to it as "whole-house heating." This convention will be followed in this review.

The normal means of central heating on the domestic scale is by low-pressure hot water under natural (gravity) circulation. The hot water is derived from any one of the suitable types of boiler described in later sections of this article.

In designing the central heating system for a particular house the first decision to be made is whether the heating is to be "full" or "partial." If it is "full," then the central heating is the sole source of heat and is required to afford full comfort conditions throughout the house; in practice, it is not uncommon for a radiant source to be used additionally in the living room, for social rather than thermal reasons. If it is "partial," this means that the heating is either in selected rooms, or is only to a background level which requires "topping-up" to full comfort in the living room by some localised form of heating, usually of radiant type. It is generally recommended that, for full heating, the design should be based on the attainment of temperatures of 65 deg. F. in the living rooms, 50 deg. F. in the bedrooms, and 60 deg. F. in the other rooms and the circulation spaces. For background heating the designed temperature should be 50 deg. F. throughout the house.

The next stage is to calculate the heat requirements of the individual parts of the house, and this involves three factors—the thermal transmittances of the various walls, floors, windows, etc., the rate of ventilation air flow, and the maximum temperature between inside the house and outside for which it is necessary to cater. The third of these factors brings in what is known as the "basic design temperature." The *Guide to Current Practice* issued by the Institution of Heating and Ventilating Engineers[7] recommends the range of 30 deg. to 32 deg. F. to cover the whole country. Other authorities, for example *Post-War Building Studies No.* 19, recommend the use of the lower of these temperatures, i.e., 30 deg. F. The subject has, however, been investigated in some detail during the last few years in relation to available meteorological data and in a report recently published[8] it is proposed that a somewhat lower basic temperature should be used. Figures in the range 28 to 30 deg. F. are suggested for various parts of the country, the value for London being 28 deg. F.

Standard tables are available, for example in *The Computation of Heat Requirements in Buildings*,[9] from which the U-value, or thermal transmittance, of the constituent parts of a building can be derived from a knowledge of their dimensions and materials. The heat requirements of each part of the house are then calculated. Standard corrections are applied where there is abnormal exposure to wind or weather. The sum of the individual requirements leads to the capacity of the boiler required for the complete service, and here it is customary to select a boiler whose rated output is between 10 and 25 per cent. in excess of this, in order to provide a margin and to remove the danger of the boiler being "forced."

It is now necessary to decide the means by which the heat shall be disseminated in each room. The traditional method is the use of radiators, which may be either of column or panel form. These are normally placed under windows, in order both to counteract cold down-draughts and to minimise dust-staining on the walls. Various alternative methods of distributing the heat are, however, available and are being exploited on an increasing scale. There are, for example, panels which can be embedded in the walls, floor or ceiling or, alternatively, coiled pipe runs may be embodied in these parts of the structure. The floor-heating method suffers from the fact that its effectiveness is impaired by the normal floor coverings of living rooms. Perhaps the most satisfactory arrangement is that of ceiling panels, which has the additional advantage that the heat distribution is spread widely over the room.

One variant of wall panel heating has recently been receiving attention. This is the "skirting-board" panel, a system which has long been used successfully in the U.S.A. under the title of "baseboard heating." Long panels at skirting-board level are used, and are assembled from cast-iron or pressed-steel sections about 2 ft. long. Both radiant and convector types of panel may be used; in the latter there are longitudinal slots at the top and bottom of the panel to permit a through flow of air past the heating sections. Various advantages are claimed for this system, including low vertical temperature gradients and a uniform sensation of warmth and comfort.[10]

Whichever method is selected for the local distribution of heat—and it is quite common for each room to be considered in the light of its particular requirements and use—there are tables of reference from which the designer may ascertain what size of unit should be used to meet the calculated heat requirements.

It is impossible to go into any detail here about the engineering requirements of a domestic central heating system, but a few points may be mentioned. The radiators are usually connected on a one-pipe ring-main system in houses, though other systems of connection may be necessary in the case of large buildings and blocks of flats. Connecting pipes of 1 in. or 1¼ in. are used for the conveyance of the water, and the system must be laid out in such a way as to prevent air-locks, and to permit of complete emptying when required. An expansion tank must be provided at a point higher than the highest radiator. Radiators may be painted in any colour provided that metallic paints such as aluminium, bronze and gold are avoided; these materially reduce the emissivity of the radiant surfaces. Finally, it is regarded as good practice, when the central heating boiler is required to supply the domestic hot water in addition, to use an indirect system for the latter to minimise interaction between the two circuits.

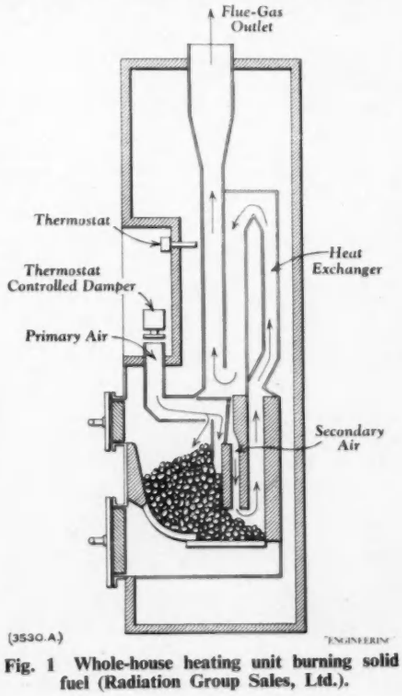

Fig. 1 Whole-house heating unit burning solid fuel (Radiation Group Sales, Ltd.).

Small-bore Forced-circulation Central Heating

The installation of a central heating system in a new house at the time when it is built is a comparatively simple matter. The requisite pipework can be concealed beneath floors and, where necessary, built into the walls. The conversion to central heating of an existing house, which was built for heating by individual appliances, presents many additional problems which undoubtedly act as deterrent factors to those who might otherwise wish to undertake it. Extensive structural work is called for, in which floors must be pulled up and replaced and walls knocked about, all on a scale which normally necessitates full redecoration after the alterations have been completed. All this adds very materially to the capital cost of the project. Nor is it generally regarded as practicable to avoid some of the difficulties by leaving the pipework exposed, since the normal size of 1in. or 1¼in. pipe is both unsightly and obtrusive in living rooms.

It was with these points in mind that the British Coal Utilisation Research Association has, over the last few years, concentrated on developing a small-bore forced-circulation system suitable for installation in existing houses, especially those of medium size (1,000 to 1,500 sq. ft. area). The use of small-bore piping, of ½ in. copper or ¾in. nominal iron, makes concealment relatively unimportant, and it has been found that, with care, holes to carry this size of piping may be drilled through plastered brick walls without damage requiring to be made good. The higher resistance of the small-bore piping makes the use of a pump accelerator essential, and it is only very recently that electrically-driven impellers of the right capacity, which are also of reasonable price and sufficiently low noise level, have become available. The electrical rating of these pumps is of the order of 80 watts.

In the simplest form of the system the thermostatically-controlled boiler is maintained at a fixed temperature, and the regulation of the central heating effected by manual operation of a mixing valve on a boiler by-pass. Domestic hot water is derived from an indirect cylinder connected to the boiler by gravity circulation in pipes of normal size. This arrangement ensures a safe outlet for surplus heat in the event of pump failure, and in normal operation a minimum of interference between the heating and hot-water functions. Later work has been concentrated on the development of a simple and economic form of automatic control system.[11]

WHOLE-HOUSE HEATING

Whole-house heating by means of warm air from a central source may be either ducted or unducted. The former must, almost of necessity, be built into a new house while it is under construction, so that the ducts may be concealed within the structure. The latter type, to ensure adequate dissemination of the warm air, is better suited to the open-plan type of house, such as is common in the U.S.A., than to the traditional roomed house of this country.

Several systems of the ducted type are available. Radiation Group Sales, Limited, market three units of basically similar characteristics which are designed to be fired with solid fuel, gas, and oil; they are intended for houses of up to 1,500 sq. ft. area.

The solid-fuel model is illustrated in section in Fig. 1. The furnace is down-draught burning, with controlled primary and preheated secondary air, so that any solid fuel can be used and bituminous coal is burnt virtually smokelessly. The hot gases traverse a three-pass heat exchanger around which air, drawn in through a filter, is blown by an electrically-driven fan and then passed to the distribution ducts. A suitably placed room thermostat controls the operation of the circulating fan, while the furnace itself operates on a high/low cycle through a solenoid-controlled damper, actuated by a pre-set thermostat in the warm air stream, which regulates the combustion-air supply.

The solid-fuel and oil-fired units also incorporate provision for the domestic hot water. This is derived from a 40 gallon copper cylinder which is heated partly by direct radiation from the furnace

Fig. 2 Open fire with large back boiler (Hattersley Bros. Ltd.).

and partly by the warm air flowing round it. A gas-fired circulator may be fitted to the solid-fuel unit, if desired, for summer water heating.

The whole unit is enclosed in a well-insulated cabinet of pressed steel which is designed for installation in a recess, usually in the kitchen. A 9in. by 9in. brick chimney with heat- and condensate-resisting lining is required.

The main form of ductless air heater available in this country is the "Weatherfoil" system. This consists of a hot-water-to-air heat exchanger operating on hot water derived from any suitable type and size of boiler. Air is driven over a bank of gilled heating tubes by an electrically-driven fan whose operation may be controlled by a thermostat at a suitable point. When used in an open-plan type of house the heating unit is contained in a cabinet standing in the main living space, heating of the upstairs space being secured by spill-over of warm air. If used in a traditional design of house the unit can be built into the ground-floor structure with two outlets for warm air, one to the living room and one to the hall.

DISTRICT HEATING

Although district heating is a subject rather on the fringe of the present review, the post-war work on it in this country is of sufficient importance to justify a brief survey. The term is used to describe the provision of space heating and hot water to a number of buildings in a locality by means of hot water or steam piped from a central station, which may be either purely thermal or thermal-electric; in the latter case the waste heat from an electricity generating station is utilised.

This system of heating has been used on an extensive scale notably in the U.S.A. and the U.S.S.R. In this country its pre-war use was confined to a few small schemes, but it was felt that the post-war period of reconstruction would afford an excellent opportunity for it to be tried in new housing estates on a wider scale. Some eleven schemes have been developed in various parts of the country.

Certain advantages and disadvantages of district heating are at once apparent:—

Advantages.—The fuel is utilised at a higher efficiency in a single large unit, as compared with a number of small units. Lower grades of fuel can be used. Atmospheric pollution is reduced since bituminous coal can be burnt with little or no smoke. Some or all of the conventional flues in the houses may be dispensed with, so reducing the capital cost.

Disadvantages.—The initial cost is very heavy, and the whole system must be ready for operation as soon as the first houses are occupied. Thus for the first few years the system may have a very uneconomic load and sustain quite severe losses. The user has to pay a fixed charge per week, summer and winter, for the service. He cannot economise in times of financial stringency, and he has no direct incentive to be economical in his use of heat.

British experience with the thermal schemes has quite definitely been disappointing. The consumption of fuel has been very heavy and the charge to the tenant considerably more than he has been accustomed to pay, though admittedly for a higher standard of heating. For example, it has been shown[12] that at East Kilbride, where the space heating is designed to be of background level only, the annual fuel consumption has averaged 6·8 tons per household supplied; this figure, it was thought, could be reduced to about 6 tons with care. In addition, however, the individual tenants have used between 1 and 2 tons of coal, or its equivalent in electricity, in topping-up to full comfort. Here, as in other district heating schemes which have been investigated, the consumption of hot water was at least twice that of the average ordinary house of the same size.

It remains to be seen whether thermal-electric schemes which, in theory, should show a greater efficiency, will lead to more reasonable fuel consumptions in practice. The only scheme of this type to be completed, that at Pimlico, supplies a district of abnormally high concentration of dwelling units, while the electricity output of the scheme represents only a small fraction (less than 1 per cent.) of the total output of the station. These two rather special factors make it unwise to regard the Pimlico scheme as typical of the class.

A cheap means of metering the heat input supplied to each dwelling appears essential to any further development of district heating in this country, and this problem is being actively investigated. One interesting solution has been quite extensively used on the Continent in flatted dwellings. In this, the "Domotherm" system, the actual distribution of heat takes place from a hot-water-to-air heat exchanger situated in a false ceiling in the hall of the flat. Heat is only dispersed in any quantity when air is driven through the heat exchanger by a centrifugal electric fan. A simple electricity meter in the fan circuit is then used as a meter of the heat supplied to the flat.

SELECTION OF APPLIANCES

After a decision has been reached as to the heating system and fuels to be used, it is necessary to select the appliance or appliances required. Here the intending purchaser has available to him sources of guidance which will assist him to choose models which have been tested and shown to be of good thermal and mechanical quality. The procedures for testing and recommendation are different for the four fuels; briefly they are as follows.

Solid Fuel Appliances.—Since 1947 all types of solid-fuel-burning domestic appliances which are suitable in respect of size and price, for use in local authority housing, have been subject to an official system of testing and recommendation. New designs are type tested by the Fuel Research Station, or in the laboratories of certain of the manufacturers who have been authorised to do this work, in accordance with procedures and minimum standards of performance laid down by the Ministry of Fuel and Power. Those appliances which are successful are included in the *List of Recommended Domestic Solid Fuel Appliances* which is prepared by the Coal Utilisation Council and the Solid Smokeless Fuels Federation in consultation with the Ministry of Fuel and Power, and published at six monthly intervals.[13] This list also includes appliances which are larger, or more expensive, than those suitable for low-cost housing. To qualifiy for inclusion these appliances must be shown to be of at least the same standards of performance as their nearest low-cost equivalent. Information is given in the list about the duties for which the various classes of appliance are suitable, together with advice as to the best types and sizes of fuels to use.

The Gas Council prepares its own list of appliances which are recommended as suitable for burning gas coke. The majority of the appliances figure also in the C.U.C.-S.S.F.F. List, but are chosen on the basis of tests carried out in various laboratories of the Gas Council and also of practical "field" tests in houses. The inception of this list goes back to 1934 and the auspices of the London and Counties Coke Association. In its present form the list is published in the *Handbook of Coke Burning Appliances*,[14] which contains a considerable amount of technical data about each appliance. Only appliances which have been approved by the Gas Council are exhibited for sale in the showrooms of Area Gas Boards.

Gas Appliances.—The Gas Council tests domestic gas appliances of all types in its own laboratories, mainly at the Watson House Centre. All appliances are tested to B.S.1250, and are examined in relation to sound engineering design and ease of installation and maintenance. Space-heating appliances are subject to thermal efficiency standards, and every effort is made to raise these standards progressively. A *List of Tested and Approved Domestic Gas Appliances*[15] is published periodically, and only appliances so approved are exhibited for sale by the area gas boards.

Electric Appliances.—Testing facilities were first set up in 1948 to assist the Electrical Development Association-British Standards Institution Advisory Committee on Electrical Appliances and Accessories in dealing with the expected spate of new electrical equipment in the post-war period. A new testing station was opened at Leatherhead by the E.D.A. in 1953. Here tests are made on all types of electrical appliances, mainly from the point of view of safety (B.S.1670) and durability; thermal efficiency is, of course, not a factor which needs examination in the case of electric space- and water-heating appliances. Some of the Area Electricity Boards themselves conduct testing work to enable them to select suitable appliances. In general the Area Boards will display and sell only those appliances which have been tested and approved either by themselves or by the Electrical Development Association.

Oil-Burning Appliances.—The major oil companies maintain laboratories in which they investigate the performance of the larger types of oil-burning equipment submitted to them by the makers. They will only recommend, through their advisory services, those appliances which they are satisfied are of a good standard in respect of efficiency, safety and durability. The smaller types of domestic heater are covered by B.S.2049, Part I.

It is a wise policy to take advantage of all these advisory services whenever possible since there are numerous appliances on the market, notably in the lower-price range of the solid fuel category, which are below standard in respect of both thermal efficiency and mechanical qualities.

AVAILABLE APPLIANCES

In the succeeding sections, the various types of appliance currently available for use with each of the four main fuels are listed, and their designs and characteristics discussed. Special emphasis has been

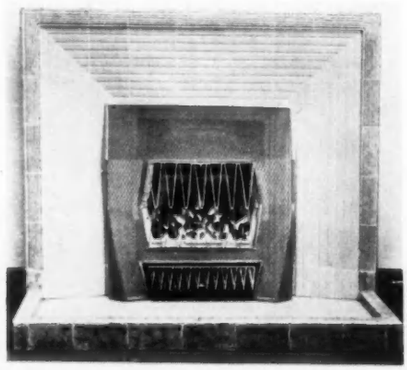

Fig. 3 Freestanding open fire with restricted throat (Newton, Chambers and Co. Ltd.). Left—as installed; right—rear view, showing fins and flue connection.

laid in this treatment on such appliances as are new or in which very substantial improvements in quality and efficiency have been effected in the post-war years. Those appliances, notably gas and electric cookers and water-heaters, which have existed in a high state of development for many years are mentioned, but only very briefly.

It is inevitable that much the greatest space and prominence should be devoted to the appliances which burn solid fuel. They cover many diverse types, and they are, pre-eminently, the class of appliance which has made the greatest strides in development in recent years. Finally, it may be well to quote one of the important conclusions contained in the report of the Simon Committee[16]: "There is general agreement that the winter space and water heating load is likely, as far ahead as we can see, to continue to be taken by solid fuel. In our view this is in the interest both of the householder and of the nation."

Appliances for Solid Fuel

The term solid fuel is used to connote all natural and manufactured solid fuels sold for domestic use. The greater part is in the form of bituminous coal. There are, in lesser quantities, the natural smokeless fuels anthracite and dry steam coal, and the manufactured smokeless fuels gas coke, furnace coke, low-temperature coke and carbonised briquettes.

Since the inception in 1947 of the Government scheme of type-testing it has been official policy that appliances intended for use in low-cost housing should be capable of burning either bituminous coal or the less reactive types of smokeless fuel. This stemmed from a recommendation of the Simon Committee, which was linked with a futher recommendation that increasing quantities of smokeless fuel, especially coke, should be made progressively available in order to reduce atmospheric pollution. The new appliances then would be ready to burn smokeless fuel when it was available, but would be effective on bituminous coal in the meantime.

Except where it is specifically stated to the contrary the appliances which are now described are capable of burning both types of fuel. Reference to the C.U.C.-S.S.F.F. *List of Recommended Domestic Solid Fuel Appliances* will show which are the most suitable fuels and fuel sizes for each class of appliance.

Inset Open Fires.—Coke-burning inset open fire grates were first developed some ten years before the war. For a period since the war there was a very heavy increase in the design and production of this type of grate, which was extensively sold under the name of "all-night burning fire." They are mainly used to burn coal, and while they have some undoubted aesthetic and amenity superiority over the old-fashioned types, there is no evidence that their use has resulted in any saving of fuel.

Numerous designs of coke-burning open fire with back boiler have also been produced. In the main these have been designed to be primarily space-heaters, and to give sufficient hot water for domestic purposes; normally there is a back flue-way with damper control by means of which the hot water output can be boosted, at the expense of the space heating, when required. There are disadvantages in all devices which are designed to perform two functions simultaneously, when the relative demands for the two functions can vary widely. In the case of the open fire with back boiler the demand for space-heating is seasonal but the requirement for water-heating is not. Thus in summer it is necessary either to provide a separate source of hot water, using electricity or gas, or to put up with the unwanted space-heating from the fire, which then represents a waste of fuel.

A development of significant importance is that of the fire with "large" back boiler; one or two designs existed before the war, and there has been a considerable expansion since. The objective is to provide sufficient hot water to give space-heating by means of radiators in other parts of the house, the domestic hot water supply preferably being obtained from an independent source. The fire then performs the one function only. The boiler is normally of large size, and its effective heating surface may be increased by making it multi-tubular, or with fins, or by providing a central flue-way; an example of this latter form is shown in Fig. 2. Remarkably high overall efficiencies are obtainable with this category of appliance.

Fires are also available which give space-heating in the form of convection as well as of radiation; they are made both with and without boilers. This class of appliance suffered severely in the early post-war years as the result of over-optimism concerning its capabilities. The convection air was often ducted to as many as three other rooms, in addition to the room in which the appliance was installed, with the result that no one heating function was satisfactorily performed. Now it is generally recommended that the convection should be returned to the room in which the fire is installed or, at most, taken to one adjacent room on the ground floor.

It may be noted that the warm air output is only obtained at the expense of some loss of radiation, as a result of the necessarily reduced insulation of the refractory fire-back. The net gain in thermal efficiency may not be very substantial, though it is probable that the mixture of radiation and convection is physiologically more satisfactory than radiation alone.

Before about 1920 it was the normal practice for open fireplaces to have some form of adjustable restriction of the outlet, either by way of a hinged canopy or a register plate. With the disappearance of this feature since that time it has commonly been the case that fires have been drawing much more air up their chimneys than was needed to clear the products of combustion. Within the last few years several satisfactory designs of adjustable restrictor, which can be inserted in the throats or above the fire-backs of existing fireplaces, have been developed. It will be appreciated that the main difficulty has been to produce a design which will satisfactorily fit in the very wide range of dimensions to be encountered in fireplaces. There is an increasing tendency, which should certainly be encouraged, for appliances which form a self-contained structure, such as boiler and convector fires, to incorporate an adjustable throat restrictor as an integral feature of their design.

Freestanding Open Fires.—The freestanding open fire is a development of some importance which has made rapid advances during the last few years, largely as the result of the pioneering work of the B.C.U.R.A. The report of the Ridley Committee[2] called attention to the desirable features of this type of appliance as a simple replacement for existing old-fashioned types of inset fire, and referred to it as a "utility" model.

The appliance being freestanding, the output is given partly as radiation and partly as convection from the hot outer surfaces, with a consequent increase in overall efficiency. An adjustable throat restrictor is fitted which, because of the relatively small front opening of the appliance, can be closed to quite a small area and still carry away the products of combustion. The rate of air flow can be reduced to 2,500 cub. ft. per hour or less.

Designers of freestanding fires have had to face two main problems—how to seal the appliance into an existing fireplace opening so as to avoid loss of convected air, and how to combine an attractive appearance with adequate heat-transfer surface in the limited space available. These problems have been tackled in various ways, and one recent design is illustrated in Fig. 3. In this case the connection from the appliance is made by means of a flexible sleeve, of woven asbestos lined with Fibreglass, coupled to a sealing plate secured with fire cement in the chimney at the top of the existing fireback. Additional heat-transfer surface is supplied by heavy finning on the body of the appliance, and is effectively hidden from view by an expanded metal surround of "contemporary" design.

Field investigations which have been carried out by the B.C.U.R.A.[17] established that when freestanding fires were substituted for normal inset fires in houses, a coal saving of the order of 20 per cent. was effected, while a somewhat higher standard of comfort was experienced. Care was taken that the appliances used were matched in output, as far as possible, to the heat requirements of the rooms in which they were used. This is a necessary precaution since their fireboxes are necessarily somewhat smaller than those of the conventional fires they replace.

Larger freestanding open fires, suitable for installation in recesses, have also been developed. It seems likely that the greater space available in such circumstances will permit efficiencies higher than those of the "utility" type to be attained. The further development of the larger types will depend, however, upon an increasing provision in new houses of an open recess in place of the traditional chimney breast and fireplace opening.

Openable Stoves.—The openable stove has frequently been described as a "typically British compromise." It is, in effect, a dual-purpose appliance. It can be run with the firedoors closed; it then gives its output largely in the form of convection and at an efficiency approaching that of the Continental closed stove, but the fire can be both seen and felt through mica windows in the firedoors. Alternatively it can be operated with the firedoors open; its output is then a mixture of radiation and convection, and the performance is of the same order as that of the freestanding open fire. Compromises usually involve some loss. In this case the efficiency when closed is not as high as it can be in a fully-closed appliance since it is not practicable to incorporate the tortuous-path flues which give additional heat recovery.

The openable stove may be inset, in which case it is built into the chimney breast, with inlet and outlet grilles for the warm air. Alternatively it may be freestanding on the hearth, in which form it will have a protective outer casing, with apertures for the passage of air around the body of the stove. It is of great importance that the primary air control should be accurately controllable, and that adventitious in-leakage of air, both above and below grate level, should be reduced to a minimum.

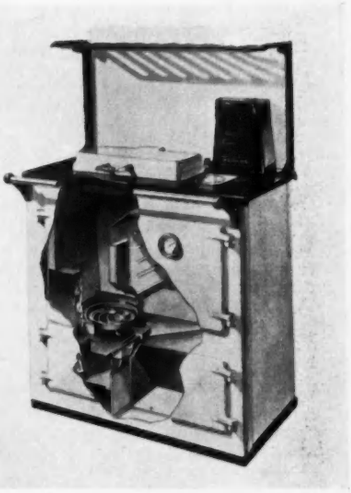

Fig. 4 Freestanding solid-fuel cooker (Allied Ironfounders, Ltd.).

Models both with and without boiler are available. Of recent years much attention has been paid to improving the external appearance of this type of appliance. In particular, several effective methods have been devised for concealing the firedoors when they are in the open position.

Closed Stoves.—Stoves which are designed and constructed to be operated always in the fully-closed condition have never achieved more than a limited popularity in this country, although they are very widely used on the Continent, where climatic conditions are more severe. Several models are, however, available. They are designed to burn smokeless fuels, and have tortuous flue-ways which give them a remarkably high thermal efficiency, of the order of 75 per cent. or above.

Combination Grates.—The combination grate performs the triple function of space-heating, water-heating, and cooking. It is made in two forms—side-oven and oven-over-fire. This type of appliance is found more particularly in the north of England and in Scotland. This difference is apparently due in part to the rather longer heating season than in the south, and in part to the more common use of kitchen-living rooms, though these two factors themselves may well be inter-related. But the oven-over-fire form, which takes up much less room than the side-oven model, is being used on a wider scale as the main appliance in small dwellings built for old people.

Both types have a cooking oven, a hinged closure plate over the fire to act as a hot plate for use with pots and pans, and a boiler to supply hot water. The side-oven model may have a warming oven or hot closet in addition. Dampers are provided by which the hot gases may be directed round the oven or round the boiler as required. When the closure plate is up and the dampers closed the appliance has the appearance and characteristics of a normal open fire.

There is a third type of triple-function appliance which may be classified with the combination grates. This is the back-to-back grate where the fire unit is in the living room and the cooking unit in the kitchen on the other side of the dividing wall. Thus the one appliance serves two rooms, and one flue can be dispensed with in the building of the house.

Freestanding Cookers.—These had their pre-war counterpart, but the designs now available represent a very considerable advance in convenience, appearance, and efficiency of fuel utilisation. The majority have closed fireboxes, though one or two cater for space-heating needs by providing an open fire. They are insulated on all exposed surfaces, generally with slag-wool. There is an extensive hot-plate, usually with a machined surface and finned on the underside to facilitate heat transfer from the hot gases passing beneath. A hinged or removable insulated "bolster" may be provided to reduce heat loss when the hot-plate is not in use.

In some cases the cooking oven is heated in what may be termed the traditional manner, by carrying

the flue gases round three sides of it, and having the fourth side adjacent to the fire. While this is an effective method of heating, it makes more difficult the task of flue cleaning, necessary when bituminous coal is burnt. There has consequently been a trend towards convective heating of the oven, the hot flue gases being carried across the top of the oven only, so that the soot deposits can then be swept direct into the firebox. The oven may then be heated either by external convection, or by internal convection. In the first of these types, of which Fig. 4 represents one model, the oven is surrounded by an air jacket, in which the warm air circulates and in turn heats the oven. In the second type a false wall, open top and bottom, is provided inside the oven itself near the face adjoining the firebox, which promotes an internal circulation of warm air. A hot closet, or warming oven, is often provided under the main cooking oven.

It is normal practice to incorporate a boiler, which is used to supply domestic hot water. Some manufacturers cater for the use of their cookers in places where there is no piped hot water, by making a model in which the boiler can be filled by hand and drawn off through a drain-cock.

The concluding part of this article will be published next week. Appliances for gas, electricity (including heat pumps) and oil will be covered.

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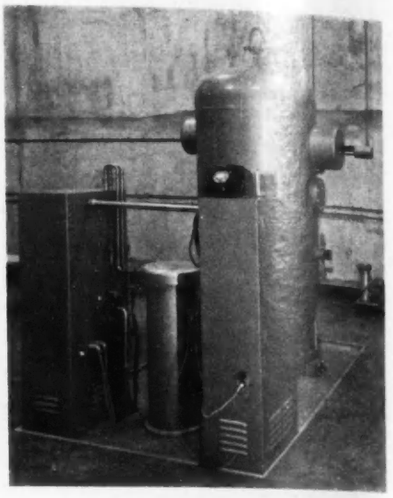


Fig. 1 Two-million volt Van der Graaff generator on floor over radiation room.

IRRADIATION RESEARCH

TUBE INVESTMENTS' LABORATORY THE FIRST OF ITS KIND IN THIS COUNTRY

In his statement at the annual general meeting of Tube Investments Limited, in December last, the Chairman, Sir Ivan A. R. Stedeford, K.B.E., mentioned that good progress was being made with the new research laboratories established at Hinxton Hall, near Cambridge, which are directed by Dr. T. P. Hughes, with Dr. F. P. Bowden, of Cambridge University, as chief consultant. The conversion of the premises, he said, was practically complete, and the construction of new laboratories was in hand. The company has further research laboratories in Birmingham and Walsall and, in addition, is forming a Technological Department to develop the practical applications of new techniques and materials up to the prototype or pilot production stage. Three sections of the department are in being. They comprise an Irradiated Materials Section concerned with developing commercial applications in this field; a Plastics Development Section; and a Control Engineering Section, the object of which is to develop the application of automatic operations in the company's factories when economically advantageous.

We are here concerned only with the Irradiation Group of the Research Laboratories at Hinxton Hall, under Dr. A. Charlesby, formerly of Harwell; the group is housed in one of the new buildings erected in the grounds and completed only recently. It is now fully equipped for the study of the effects of atomic radiation on the chemical and physical properties of certain materials. We understand that this laboratory is the first in this country to be designed specifically for research work of this character. The work is not yet sufficiently advanced for details of results to be given, but the equipment is now in operation and some preliminary experiments have been made. We were able to see some of these during a visit to the laboratory, by invitation of Tube Investments Limited.

SYNTHESISING MATERIALS

High-energy radiation enables a range of both new and modified materials to be synthesised, some of them having numerous industrial and

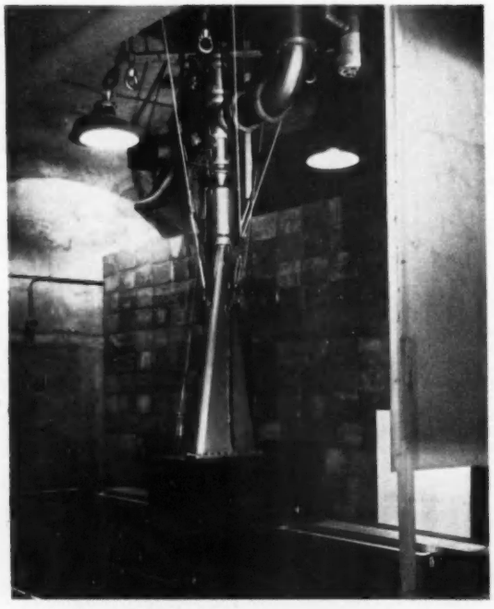


Fig. 2 Lower end of accelerator tube which directs high-speed electrons on to the specimens.

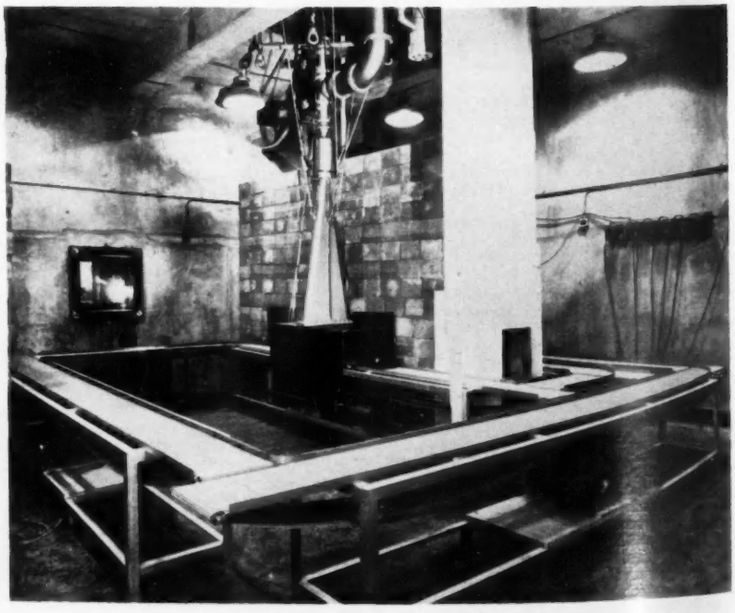


Fig. 3 Interior of radiation room, showing conveyor system which takes specimens to and from the electron beam.

Fig. 4 Part of control room, showing control desk for Van der Graaff generator, observation window and monitoring equipment. The window consists of many plates of ¾ in. glass and, to eliminate multiple reflection, the spaces between plates are filled with medicinal paraffin oil.

domestic applications. Of particular interest are the chemical reactions which take place when plastics are subjected to radiation treatment. The latter may, in fact, supersede certain chemical processes in use at present involving heat and chemical reagents. Various forms of high-energy radiation may be used to effect these changes, including a stream of very fast electrons, X-rays or gamma rays, all of which may be derived from elements undergoing nuclear changes. Other methods of producing high-energy radiation, however, are available which do not involve nuclear changes. These are high-voltage machines which accelerate electrons or atomic particles to energies of several million volts. The power output from these machines is much higher than can be obtained conveniently from existing atomic piles and they are much more flexible in use.

Another important advantage of the electrical accelerators is that the irradiated materials are completely free from retained radioactivity and can be handled immediately after treatment. Until recently, investigations of the changes produced by irradiation have been mainly on a small laboratory scale although some of the experiments have shown promise. The equipment at Hinxton Hall, however, is designed to carry on this work on a larger scale and with a greater degree of precise control.

VAN DER GRAAFF GENERATOR

Of the sources of radiation available there, the principal is a generator of the Van der Graaff type, constructed by the High Voltage Corporation, Cambridge, Mass., U.S.A., and capable of producing a two-million volt beam of radiation with an energy of 500 watts. The building in which it is housed consists of a two-storey central portion with single-storey wings on each side. One of the wings contains the control desk for the main accelerator, shown on the right in Fig. 4, an X-ray set operating at 250,000 volts, another X-ray set operating at 50,000 volts and a high-intensity radioactive-cobalt source giving gamma radiation of high penetration.

The Van der Graaff generator is installed on the upper floor of the central part of the building and is shown in Fig. 1. It is enclosed in a steel casing and operates under high nitrogen gas pressure, which has enabled the size of the installation to be greatly reduced. In the same steel casing is the vertical accelerator tube in which electrons produced by a heated tungsten filament at the top are accelerated downwards by the potential produced by the Van der Graaff generator. The accelerator tube extends downward into the radiation room on the ground floor and terminates at the bottom in a flared section closed by an aluminium window through which the high-speed electrons are directed on to the specimens to be treated. Fig. 2 shows the bottom end of the accelerator tube in the radiation room. Articles for irradiation are brought by a series of wire-mesh conveyor belts from the control room into the radiation room and under the beam, which scans individual specimens by electromagnetic means controlled externally by the operator. The conveyor system is best shown in Fig. 3. External controls of the speed of the conveyor belt enable the radiation dose and time of irradiation given to each specimen to be varied at will. An elaborate system of warning devices and interlocks is arranged to protect the operating personnel and constant monitoring for stray radiation is available in the control room. As has been mentioned, however, the specimens have no induced radioactivity so that they can be handled as soon as they are removed from the beam. Normally they travel on the conveyor, after treatment, into the control room, but if it is desired to examine them immediately, the operator can enter the radiation room without any risk if the beam has been cut off; the interlock, of course, prevents entrance while the beam is on.

The second wing of the building is at present used as a test laboratory, but it is arranged so that it can be converted to accommodate large specimens that can be fed into the radiation room for treatment under the beam. The preparation of the specimens and the subsequent study of the effects produced will eventually be carried out in a separate laboratory building now under construction. The present building has concrete walls 3 ft. in thickness and lead-lined doors are fitted to protect the personnel against radiation. A window in the wall of the radiation room enables the specimens to be watched from the control room while undergoing treatment. This window, which can be seen in Figs. 3 and 4, is composed of 41 plates of ¾ in. glass with a space between each pair of plates. The spaces, it may be noted, are filled with medicinal paraffin oil in order to eliminate the multiple reflections which otherwise would render direct vision impossible. A separate chamber houses the heating and ventilation equipment.

As already mentioned, the programme of work to be carried out with the radiation equipment available includes both research and development. In the first place, the effect of irradiating plastic materials will be studied, since it is known that very useful changes can be brought about in materials such as polyethylene, nylon and rubber. At the same time, fundamental research into the method by which radiation interacts with materials will also be undertaken. It is intended to collaborate with other organisations and research associations in various fields of work ranging from biology and medicine to chemistry and engineering which, from the point of view of radiation, have many interests in common. It seems not unreasonable to anticipate therefore that some useful additions to scientific knowledge will be forthcoming in the not far distant future.

DIGITAL COMPUTERS ACCEPTED AS WORKING TOOLS

A convention on digital computer techniques, which had been organised by the Measurement and Control and Radio and Telecommunication Sections of the Institution of Electrical Engineers was held at Savoy-place from April 9 to 14. There were ten general sessions at which papers covering the engineering, scientific and business applications of computers and their application in industrial control were presented. In addition there were seven specialist sessions at which such matters as numerical analysis, rapid-access storage and circuit techniques and components were discussed. Short accounts of the principal general papers are given below.

OPENING ADDRESSES

The first meeting on April 9 was presided over by the President (Sir George Nelson, Bart) and an opening address was given by the President of the Royal Society (Sir Cyril Hinshelwood) in which he said that it was interesting to consider the diverse tributaries which had flowed together to constitute the modern stream of throught on digital computers. Without the cogitations of Boule and others on the relations between mathematics and logic it was doubtful whether the subject would ever have been initiated. Without abstract interest in the theory of numbers it would have been impossible to translate logical alternatives into simple matematical form. Without the discovery of the thermionic valve and of its alternatives the necessary speed of operation of the various "gates," indispensible for any practical machine, could never have been achieved. And without the discovery of a whole range of fascinating electrical and magnetic phenomena the creation of "delays" and "memories" could never have reached its present development. The philosophy underlying the equipment was not merely an afterthought about results, but an essential part of the whole conception. The same was true of mathematics, which was not a mere tool of execution.

There was scarcely a branch of science in which the application of rapid efficient calculation did not offer a prospect of solution of problems hitherto quite intractable. The displacement by machines of a large amount of manpower would, of course, effect an enormous saving. On the other hand, the education of persons capable of designing, manufacturing, maintaining and programming such machines would be very difficult. The mechanisation of office work should, however, solve the problem of the de-grading of the clerical worker.

Thus science would become very intimately bound up with human affairs. It was therefore necessary that men of science should play the part of leaders or there would be trouble indeed. The different kinds of work and speculation which the existence of computers would stimulate afforded great encouragement to the general study of the relations between language, logic and mathematics.

POWERFUL NEW WEAPON

Professor F. C. Williams then delivered an introductory lecture in the course of which he pointed out that the Convention was being held to record that something revolutionary was being offered to the country and to describe the rapid development which had taken place in the technique and application of the equipment. The digital computer was a powerful new weapon for the user, as might be illustrated by the way it was being increasingly employed in many different fields. The reasons for this were that it was speedy in action, automatic in operation and universal in the sense that it could be used to solve any type of problem. Experience, too, had shown that it was exceedingly free from errors, reliable and that its cost per operation was low.

Development in design, he went on, was likely to continue and improvements would render the employment of computers more attractive. At the same time he did not think that there would be any major

advance in design, although the increasing use of the transistor would enable the size of the equipment and the power consumption to be reduced. Close attention would have to be paid to solving the problems of storage, since present methods were costly and not altogether satisfactory. Universality would have to some extent to be abandoned in favour of machines for solving particular problems. The demands of scientists and industrialists were different; and universality would perhaps have to be discarded in favour of machines suitable for solving particular problems.

The employment of computers in engineering would enable trial structural designs to be rapidly examined, to take only one example, while in commerce they would eliminate a good deal of human drudgery. This would enable more outlets for the exercise of the highest qualities of human brain to be found.

ENGINEERING AND SCIENTIFIC APPLICATIONS

The General Session on Tuesday morning was devoted to a consideration of the engineering and scientific applications of digital computers; eight papers were presented.

Mr. J. M. Bennett, dealing with "Digital Computers and the Load Flow Problem," set out a technique for determining the current flows and voltages in an electrical distribution network with an automatic digital computer. The method used was one of successive approximation. Initially, the voltages at all the busbars were assumed to be in phase and from a knowledge of the power consumed or generated at each busbar, the corresponding currents could be computed. From these currents and a knowledge of the impedances and interconnection of the branches, an approximation to the voltages at the busbars was obtained. The process was continued until it converged. The work was done on the Manchester Universal computer, the bulk of the problem consisting of setting up and solving the equations connecting currents at the busbars and the voltage drops between them. The advantages and disadvantages of this process compared with a network analyser were discussed.

In a paper on the "Use of Interpretation Routines on a General Purpose Digital Computer for the Design of Linear and Non-Linear Control Systems," Mr. W. D. Worthy pointed out that it had been customary to use analogue computers employing feedback amplifiers for the investigation and improvement of servo-mechanism designs. If non-linear devices were included they needed special adjustment for each problem and in some cases it was impracticable to reproduce a non-linear characteristic over all portions of the range. Programmes could, however, be devised so that a general-purpose digital computer could be used for the study of control systems, for the machines provided almost unlimited facilities for representing non-linear elements. Although the time required for computation was longer than with an analogue computer the potential accuracy was greater and a permanent record of all variables was readily available. Parameters could easily be varied and the results presented for comparison just as simply as on an analogue machine.

TRACTION PROBLEMS

On railways, traction performance calculations were used to determine the most suitable design of equipment for carrying out a certain task. As pointed out by Mr. A. Gilmour in a paper on "The Application of Digital Computers to Electric Traction Problems," these calculations were extremely laborious if carried out by hand and machines had therefore been devised which enabled the work to be done in about one-tenth of the time. This period could be reduced by a further factor of between 10 and 20 by the employment of a digital computer.

A typical calculation was carried out in three main stages. First, information regarding gradients, curves, speed restrictions and the positions of stations were punched on cards in decimal form. The computer was then used to calculate the gradient and curve resistance and to punch these values and other gradient and speed restriction data in binary form. The second stage dealt with the power/speed characteristics of the locomotive and the resistance of the rolling stock. The time taken by the computer to calculate tractive effort for a given speed from data provided by algebraic-polynomial graphs was less than 20 milliseconds; or equivalent to that taken for a man to read the appropriate value from a graph.

In the final stage the main programme was fed into the computer followed by train performance data, the gradient resistance and speed restrictions. The computer would then calculate the speed and time at each point of the journey by solving the equations of motion by a step-by-step process. It would also accumulate a running total of energy consumption and data from which the root-mean square current might be derived. At each step it would check that the speed was not higher than the local restriction and that the train had not yet reached the point at which the brakes were to be applied to reduce the speed to the next restriction. When this point was reached, the computer calculated the time taken to brake to the next restriction and when a station was reached a card was punched showing the distance travelled, the time taken, the energy consumption and the root-mean-square current for the previous section.

Other applications to traction engineering, in which a digital computer might be of use, were stress problems in the design of overhead structures and bridges, and the study of rectifier harmonics.

ELECTRIC CIRCUIT PROBLEMS

Dealing with the "Use of Digital Computers in Obtaining Solutions to Electric Circuit Problems Involving Switching Operations," Mr. S. J. M. Denison and Mr. D. G. Taylor pointed out that the equations for circuits containing linear elements could be expressed as simultaneous, linear first-order differential equations with constant coefficients. A programme for solving such equations on a Deuce computer by a step-by-step method had been evolved and could be used for solving many switching problems.

For a single switching operation the procedure was to establish the equations for circuit configuration after the switching operation and to solve them from known initial conditions for a suitable duration. A problem involving a number of sequential switching operations could be dealt with as a series of single problems, the final conditions for one problem providing the initial conditions for those following.

In general the equations for each part of the problem were different and the procedure became tedious where the number of switching operations was large as was the case with rectifiers. Certain well-known types of power rectifier installations could, however, be represented by a small number of equations describing the complete circuit; and two programmes had been made for calculating the fault conditions subsequent to a backfire in a three-phase rectifier and the normal operating conditions in a bi-phase rectifier.

POWER SYSTEMS AND DESIGN

In a paper on "Power System Engineering Problems with Reference to the Use of Digital Computers," Mr. C. Robinson and Mr. D. H. Tompsett pointed out that the employment of this equipment was most easily justified when existing methods were inadequate or uneconomically time-consuming, as well as if they were less accurate, less economic or less direct in formulation. This argument was illustrated by discussing load dispatching on an interconnected system where the complexity of the analysis had so far precluded the achievement of more than an approximate solution. Load-flow studies, as normally specified, might in some cases be soluble and in others have more than one solution. Digital methods had, however, recently been developed to deal with this problem. Other computational problems discussed were the analysis of load curves, and three-phase circuits, while a number of other applications for digital computers included transmission-lines calculations, lightning-arrester operation, and heat balance and hydraulic problems, for all of which more rapid and accurate solutions could be obtained than by other methods.

The value of the digital computer as an aid to the electrical design engineer was discussed in a paper by Mr. B. Birtwistle and Miss B. M. Dent. They gave examples relating to problems concerning impulse-voltage distribution on transformer windings, supply frequency ripple on transductor performance and the starting torque of a synchronous motor. In each case the advantage of the high-speed computer compared with previously existing numerical methods, was greater rapidity. It was also possible to undertake much larger computations than would otherwise be contemplated and for more designs to be tested for the required characteristics in the time available. As the computer could be programmed to perform not only arithmetical processes, but the whole organisation of a problem it could relieve the design engineer of that part of his work which involved no experience or judgment and thus release him for more creative effort.

BUSINESS AND INDUSTRIAL APPLICATIONS

Two General Sessions on Tuesday afternoon were devoted to discussing the business applications of digital computers and their application in industrial control.

Mr. D. W. Davies described a digital computer with magnetic-tape control which was used for sorting, attention being given to the organisation of transfers between the computer and tapes and the management of tape-reel changes. Sorting problems, he pointed out, were of many different kinds depending on the characteristics of the data to be sorted. These different processes were required according to the circumstances not only for efficiency, but to preserve order. In the course of a review of the various methods he indicated that a difficulty was the insufficiency of the terminology that had been invented to express the ideas and processes. Some new terms were therefore introduced and the meaning of existing terms were defined.

A paper on the application of digital computers in the explanation of functional relationships was presented by Mr. G. E. P. Box and Mr. G. A. Coutie. Short contributions on the use of a computer for pay-roll work were made by Mr. E. A. Newman and Mr. M. A. Wright and on Gamma 3 and magnetic drum extension by Mr. P. Dreyfus.

PRODUCTION MACHINES

Three General Sessions on Wednesday, April 11, were occupied with the presentation and discussion of eight papers and five short contributions on the construction and performance both of commercially available and experimental machines.

Describing "Deuce," Mr. A. C. D. Haley said that this was a high-speed general purpose binary digital computer operating in the serial mode at a digital frequency of one megacycle and using mercury delay lines. It was a development of the pilot model Ace and contained a number of operational improvements as well as additional features which facilitated maintenance and reduced the problems of testing new programmes. Both input and output were by means of high-speed punched-card machines and a large-capacity (8,192 words) magnetic drum store augmented the main mercury-delay-line storage system. The construction of the machine was briefly described and reference made to some of its applications.

Mr. K. Lonsdale and Mr. E. T. Warburton gave details of "Mercury," which was a production computer developed from a design originated at Manchester University, the main difference being a modified order code. It also incorporated a core-matrix store to provide the immediate access memory, while as an additional safeguard against storage errors an automatic parity check was provided. The increase in capacity of this store to 40,960 binary digits had necessitated a change in the address system. The backing store consisted of four magnetic drums with a working capacity of 163,840 digits. Electronic track switching had been introduced to increase the transfer speeds between the backing and fast-access stores. Computation was effected serially at 1 microsecond per digit, while transfers to and from the immediate-access memory were through ten parallel channels each operating at 10 microseconds per digit. The backing store operated serially at 5 microseconds per digit. The first production model was equipped with a 200 characters per second paper-tape reader and a 25 characters per second paper-tape punch.

COMMERCIAL COMPUTING

The HEC4E computer described by Mr. R. Bird was designed specifically for commercial calculations. It was an electronic digital machine which functioned in the serial binary mode, the pulse repetition frequency being 40 kilocycles and the word length 40 binary digits. The main storage for both numbers and instructions was a magnetic drum having 64 tracks, each of which held 16 words. Besides being able to perform all four arithmetic functions automatically the machine could convert to and from the binary scale for any normally used scale of notation.

The input was by standard punched cards and both a printing mechanism and a card punch were provided for the output of results. The machine was constructed in four parts: the electronic unit, which contained about 1,100 thermonic valves; the operating console, providing manual controls and a visual display of the course of calculation; the tabulator which provided both punched card input facilities and the printed output; and the card-punching output mechanism.

A programme-controlled computer, a paper on which was presented by Mr. E. J. Guttridge and Mr. R. P. B. Yandell, had been designed for commercial work. The 160 programme instructions, each of 24 binary digits, are not entered into the computing store, but are set up on switches. In addition 80 instructions of a similar type were "built-in" as sub-routine. As soon as one instruction had been obeyed the computer could proceed with the next. The main advantage claimed for this method is an immediate access to the instructions.

The basic pulse frequency of 40 kilocycles was chosen, as it was considered that the standard of reliability required could thus be achieved without

high tolerance components. As the amount of input and output data might be high it was decided to operate throughout with numbers in sterling or decimal form. In spite of the low pulse frequency the operating speed was quite high. Words were stored on a magnetic drum with a capacity of 160 20-digit words on four tracks. Further tracks were used for input and output storage. Six one-word immediate-access stores were provided on the drum and there was also "flip-flop" storage for control information. Input and output were by punched cards, the card speed being normally 120 cards per minute.

A detailed account of an electronic calculator for punched-card accountancy was given in a paper by Mr. L. Knight. This machine, which contained about 900 valves, had relatively few basic circuits, would read numbers off a card, calculate new information from these and punch the answers back onto the same card. About 100 cards per minute could be handled. It could add, subtract, multiply and divide in both the decimal and sterling notations and could be easily pre-set to perform any sequence of these operations. The sequence could be modified by special instructions on the card or as the result of a step in the calculation.

MANCHESTER COMPUTER, MARK II

The Mark II digital-computing machine now operating in the Computing Machine Laboratory of Manchester University was dealt with by Mr. T. Kilburn, Mr. D. B. G. Edwards and Mr. G. E. Thomas. Mathematical experience with the prototype machine (Mark I), which was put into operation in 1951 indicated that improvements were desirable and possible in three directions. An increase in the speed of computation would increase the total amount of computation performed in a given time and would make it possible to solve some "real" time problems, notably in weather forecasting. The provision of a floating-point accumulator would make the machine easy to programme and thus contribute to the overall efficiency. Moreover, a further increase in speed would follow for those problems in which floating point operation was required. Although the Mark I machine had had a good reliability record a decrease in size should reduce the labour of servicing and improve the efficiency.

It was therefore decided that a new machine should be built to incorporate these three items, but that the large capacity-backing up store in the form of a magnetic drum should be retained, together with the B-modification facility, which would be extended. Economy would be achieved by new engineering design techniques and logical improvements, e.g. in the method of fast multiplication.

In many respects the requirements of an increase in speed and a reduction in the labour of servicing conflicted, but the main conflict which was between a completely serial machine on the one hand and a completely parallel machine on the other, was, however, resolved by operating the control and accumulator sections in a serial manner at one megacycle to give a basic increase of ten in speed. Thus a high-speed store was required to provide and accept serial information at a digit repitition rate of one megacycle per second with immediate access.

CATHODE RAY ACCESS STORE

The available types of immediate-access store limited the choice to the cathode-ray tube type or a magnetic core matrix type and both had a practical upper limit of operating speed of about 100 kilocycles per second. A cathode-ray tube store of 10,000 digit capacity was adopted for the Mark II computer, though precautions were taken to permit both an extension of storage capacity to 40,000 digits and a rapid conversion to magnetic core storage, if desired. The main store thus consisted of ten cathode-ray tubes operated in parallel at a recurrence frequency of 100 kilocycles, the ten outputs or inputs being combined to give, or accept, serial information along single channels at a digit frequency of one megacycle. By this combination of serial and parallel operation, speed and economy were achieved simultaneously.

ACOUSTIC-DELAY-LINE CALCULATOR

Mr. J. A. Tempel described an acoustic-delay-line electronic calculator which was designed to perform accounting and other calculations. It was capable of performing addition, subtraction, multiplication and division. It received information from a punched card, performed the required calculations and punched out the answer on the same card.

The calculator was divided into: the arithmetic unit, delay-line store, control unit and input/output system. The information to be operated on was transferred from a punched card through the input system to the store. It was then fed as required to the arithmetic unit where the decimal calculations were performed. The results were fed back to the store and then through the output system back to the card. A Hollerith punch was used as the input/output organ, the "read-in" and "read-out" processes occurring simultaneously. While information was read out from the first card new information was read in from the second card. Calculation then took place in a fixed time of 85 milliseconds before information was read out on to the second card and read in from the third card. After each transfer of information was completed, the punch carried a signal to the electronic unit, which then began to calculate.

The calculator store has a capacity of 23 words consisting of a 10 digit decimal number. A long delay-line store accommodated 20 words of information. Three one-word delay-line stores contained the remainder. The circuit elements were few, the most important being the trigger circuits, binary adders, pulse and direct-current gates, inverters and pulse stretchers. The main features of the machine were ease of programming, low-power consumption, low cost of production and facilities for easy servicing.

A number of short contributions were also presented at these sessions. Mr. M. P. Barnett described 650 and 700 series computers and Mr. A. Johnston the 400-405 series. Information on the Pegasus, Edsac II, Nicholas, Ace and Imp computers was also given.

THE ROLE OF THE TRANSISTOR

The General Session on Thursday morning, April 12, was devoted to a consideration of four papers on the part played by the transistor in computer design and construction.

The first by Mr. E. H. Cooke-Yarborough, Mr. R. C. M. Barnes, Mr. J. Stephen and Mr. G. A. Howells described a small digital computer, which had a magnetic drum store and used some 330 transistors as the only active circuit elements. The "logical" design of this machine was unusual, as it involved the interleaving of the digits of numbers stored on the drum. This permitted three-address operation, all three addresses being on the drum; and called for relatively little storage capacity external to the drum. The time taken to perform individual operations was rather long, both because the basic pulse frequency must be low to avoid hole-storage effects in the germanium and because the conventional high-speed storage arrangements were difficult to apply. These disadvantages had, however, been minimised by the use of principles designed for a storage system with a long access time.

INTERLEAVED DIGIT COMPUTER

In a second paper, Mr. R. C. M. Barnes, Mr. G. A. Howells and Mr. E. H. Cooke-Yarborough dealt with transistor circuits for an interleaved-digit computer. These had been developed from earlier transistor circuits used as computer elements, and a description was given of various gating circuits, which formed the standard elements from which a digital computer had been constructed. The application of these standard circuits to the arithmetic unit of the computer was illustrated by two examples: an adder of unusual logical design to suit the interleaved-word storage system and a multiplier system which formed the signed products of two 31 digit binary words in six-word times.

The authors pointed out that the use of gating circuits containing a storage condenser appeared to offer several advantages. Functions, such as short-term memory and revisal, could be performed which would be difficult to achieve with gates using only diodes and resistors. Although the computer was only an experimental model it was proposed to put it into regular use in that form. It had already performed numerous self-checking programmes, which had been prepared to test it.

An interleaved-digit magnetic drum store for a transistor digital computer was the subject of a paper by Mr. J. H. Stephen and Mr. E. H. Cooke-Yarborough. In this it was shown that it was possible to design and operate a magnetic drum store functioning at a basic pulse rate of 58 kilocycles per second using transistors as the only active circuit components. The store had been integrated with the experimental digital computer using transistors, dealt with above, and the complete system executed complex test routines for hours without error.

The design required the interleaving of the digits of the words, an arrangement which made many words on the drum available concurrently and therefore permitted economical three-address operation. The working store had a capacity of 420 words, including a regenerative loop which was necessary for temporary storage, since not all the words were available concurrently. The proposed main store, which would be relay-selected, had a capacity of 16,384 words.

The design of a prototype transistor digital computer and a full-scale machine was described by Mr. T. Kilburn, Mr. R. L. Grimsdale and Mr. D. C. Webb. These machines were the result of a decision to build a relatively small and economic equipment at the same time as the large-scale digital-computing machine, Mark II, of Manchester University. Initially, thermionic valves were to be used throughout, reduction in size being obtained primarily at the expense of operating speed. Towards the end of 1952, point-contact transistors were becoming available in sufficient numbers and their use proving to give still further economy, the project took the final form of a transistor/magnetic drum computer.

The general arrangement of the two machines was similar and both employed a magnetic drum for the main and auxiliary stores. The latter were provided by regenerative tracks, or revolvers, which had reading and writing heads spaced by a distance equivalent to one, two or eight word periods. The output of the reading amplifier was connected through a gate to the writing amplifier and the track operated as a delay-line type of store.

Point-contact transistors were used principally as pulse amplifiers and staticisors and for wave-form generation. In the pulse amplifier the transistor operated as a two-state circuit. It was turned on by a digit pulse and re-set at the end of each digit period by a regular clock wave form with a pulse repetition frequency of 125 kilocycles. Point-contact diodes were used to perform the logical operation and for gating. Two-static circuits employing single transistors were also used for the staticisors and for the wave form generation units. A pseudo two-address code was used in both machines. Both the address operand and the address of the next instruction were specified in each instruction to permit a reduction in the access time by optimum coding. The full scale machine had an eight-word B-register, which might also be used as a rapid-access number store and an automatic multiplier.

INPUT AND OUTPUT PROBLEMS

On Thursday afternoon three papers were presented on input and output, including analogue/digital conversion. In one of these Mr. F. Beckett described apparatus which accepted pulse signals representing 11 digit binary numbers and from these generated voltages proportional to the magnitude of the numbers. The output voltage was available for display for at least 400 microseconds within 700 microseconds of the number being fed in. Re-setting occupied a further 300 microseconds and the apparatus worked continuously on a 1·4 millisecond cycle. The conversion took place in two stages. In the first, a time analogue of the number was generated by a crystal-controlled binary counter and in the second a linear time base produced a voltage proportional to this time interval. The apparatus was in use on a data-processing project where it was necessary to set up a de-coder which would obtain from information coded in digital form an analogue of the digitally coded quantities.

Remote position control and indication by digital means were dealt with by Mr. W. S. Elliott, Mr. R. C. Robbins and Mr. D. S. Evans, who pointed out that in some applications, for example on an accurate radar equipment, it was desirable to convert the angular setting of a shaft to digital form with high accuracy. For this purpose a master binary disc was made photographically on a dividing engine. A photographic copy of this disc was then coupled directly to the shaft whose setting was to be measured and was scanned to produce a digital signal representing the shaft angle or a function thereof.

A number of convertors were made with scales subdivided to give an accuracy of the order of one minute of arc. They were used under conditions of severe vibration and exposure and amply demonstrated the principle of the high accuracy binary dise. A follow-up servo-mechanism was also made in which one shaft followed another by a digital link to an accuracy of one minute of arc. The limitation of accuracy was in the production of the binary discs. The master pattern could be subdivided and the photographic emulsion had angle resolution, but further work was necessary on the avoidance of small blemishes in the photographic processes.

The papers presented at the specialist sessions, which were held simultaneously with the general sessions included, under the heading of numerical analysis, one on the method of Lanczos for calculating the latent roots and vectors of a real symmetric matrix, on programme strategy and on the solution of non-linear heat-conduction problems. The design of operational codes for automatic computers was also considered and an automatic floating address system was described.

The complete proceedings of the Convention are to be published in supplementary issues of Part B of the *Proceedings* of the Institution.

Book Reviews

CHEAP PERSONAL TRANSPORT

The History and Development of Cycles as Illustrated by the Collection of Cycles in the Science Museum. Part 1: Historical Survey. By C. F. CAUNTER. *Science Museum, South Kensington, London, S.W.7*, and *H.M. Stationery Office, Kingsway, London, W.C.2.* (4*s.*)

Of all the countless applications of man's ancient invention, the wheel, none is perhaps better known than the bicycle; certainly none is more obvious. The bicycle has had a considerable influence on the history of the human race in the last 80 years or so, and to-day about 12 million machines are in use in this country alone, while very many millions more are used throughout the world.

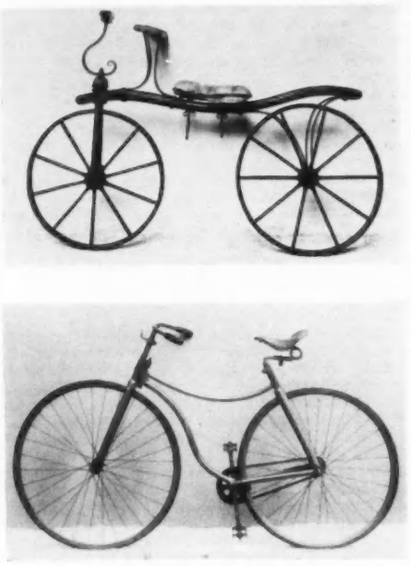
The possibility of constructing vehicles propelled by human muscular effort was considered in ancient times, but no developments are recorded. Such vehicles were, however, known in the Middle Ages, and from the Seventeenth Century onwards several were made, to be propelled either by the hands or feet. All these vehicles were carried on four wheels, and they can only be regarded as the ancestors of the bicycle, the first true example of which appeared in 1791 in France. This machine was propelled by the rider thrusting at the ground alternately with his feet, but as it could not be steered it was of little practical use. It did, however, demonstrate the fact that a two-wheeled machine could be balanced easily, and it was capable of considerable speed.

In 1817 Charles, Baron von Drais de Sauerbrun, of Mannheim, produced his " Draisienne," which had a wooden frame and a steerable front wheel; it was still propelled by thrusting at the gound with the feet, but it was in all respects a much more practical vehicle and it was adopted widely, particularly in France, England and Germany. By about 1836 the Draisienne or hobby-horse was out of fashion, and for some years the history of the development of the cycle is somewhat obscure. Tricycles and quadricycles were built, and it seems likely that experiments with the bicycle were continued.

A pedal-propelled bicycle, the first of its kind, was invented by a Scotsman, Kirkpatric Macmillan, in 1839, and by about the year 1860 ideas on the subject began to settle down. From that time onwards the pedal-propelled bicycle was an object of considerable interest, and its development was more rapid. The principal machine of the 1860's was the velocipede, or, as it was known in this country, the " boneshaker," which was similar to the hobby-horse in appearance but was propelled by mans of pedals on the steerable front axle. It was developed vigorously in France, the country of its origin; in fact France was years ahead of any other country in the cycle field when the Franco-Prussian war of 1870 brought her activities to an end.

By this time the British cycle industry was active, particularly in Coventry, where the Coventry Sewing Machine Company had taken an order for 400 boneshakers for export to France. The Franco-Prussian war interfered with the firm's plans, and it was decided to develop the home trade instead. The sewing machine concern, its name changed to Coventry Machinists Company in accordance with its new activities, went ahead rapidly, and the British cycle industry expanded, some well-known names now coming into prominence; these included Rudge and Humber, and in particular J. K. Starley, who was responsible for many important design improvements.

The industry then entered a period in which lighter construction, with a consequent reduction in physical effort on the part of the rider, was prominent. The most popular machine in the decade beginning in 1875 was the " ordinary," or " penny-farthing." By comparison with the crude and heavy boneshaker, which it superseded, it showed a great advance in design, though its



Two stages in the development of the bicycle: the hobby-horse of 1818 and J. K. Starley's Rover safety bicycle of 1885.

appearance was curious by present-day standards. The principle disadvantage of the ordinary cycle was that it demanded considerable skill on the part of the rider; its centre of gravity was high, and a fall from it could be unpleasant, to say the least. It is not surprising, therefore, that the next development should take a different form. In 1885 Starley introduced his " safety " bicycle, which more closely resembles present-day designs. From this time onwards, though many improvements were made, and numerous ideas were put forward, the safety bicycle remained supreme, and it is in this form that it has developed into the universal means of personal transport it is to-day.

Such is the outline history of the bicycle. Parallel with the various developments in basic design there have been many changes in detail, some of them very important. The introduction of the ball bearing and the pneumatic tyre, for example, are both essential steps in the development of the cycle. Accessories and fittings, such as lamps, speed gears and brakes, have also undergone many changes before arriving at the present stage of development, and these changes, like the history of the basic machines themselves, are reviewed in considerable detail in this Science Museum book.

Literature on the history of the bicycle is far from abundant, and the present work brings together in a concise and readable form much information which it would not be easy to obtain elsewhere. It is very well illustrated with reproductions of photographs, and there is just sufficient condensation in the whole work to bring it to a reasonable size and price without sacrificing any of the essentials. A useful bibliography is provided, and there is an index which is quite extensive, but would be improved by a little more coross-indexing and a few more entries. It would also be a help to the reader if direct textual reference were made to illustration numbers; as it is, an illustration of a particular machine mentioned in the text must be sought by looking through the plates.

SQUARE PEGS IN SQUARE HOLES

Success and Failure in Industry: A Psychomedical Study. By DR. M. R. VAN ALPHEN DE VEER. *Van Gorcum and Company, N.V., Assen, Netherlands.* (13.50 Dutch florins.)

For many years now, at least since the results of the work of Elton Mayo at the Western Electric Company's Hawthorne Works were published, more and more attention has been paid to the psychology of the worker in industry. It has been increasingly realised that the industrial situation, particularly in large-scale industry, is an " unnatural " one, in that it has developed rapidly during the last century and a half from forms of social organisation that had persisted with relatively little change for thousands of years. The impact of industrial life on man has therefore been examined from the point of view both of its effect on his individual personality and on his relationship to his work and co-workers.

Dr. van Alphen de Veer is deputy-director of the Health Centre of Philips Industries at Eindhoven which is charged with the curative, preventive and constructive care of the health of 30,000 employees and their families. It provides many opportunities for the study of the relationship of the individual to his work situation, and one result was the discovery that approximately 40 per cent. of a random sample of 300 employees showed symtoms of psychic or psychosomatic disorders as the consequence of maladjustment to their surroundings either in industry or the home. In an endeavour to find the causes of this phenomenon detailed studies were made of the lives and personalities of 30 employees, drawn from all ranks, of whom half were failures and half were enjoying successful careers and the results are contained in this book. The studies made of these individuals were very thorough indeed, and the varied methods and tests employed are not easy for a layman to understand.

Broadly, this approach is concerned not only with the scientific method which makes use of objective data, but also with the data supplied by phenomenological psychology, which tries to discover, in the author's words, " whether, in a given situation, the individual is able to realise himself, i.e. (according to existentialist anthropology) does the individual, standing in the world of industry, show the affective disposition of openness toward the world and will he by a true association with this world be able to reach toward the future in an ever increasing realisation of his true self."

In practice an attempt was made to answer four questions: (1) Does industry show certain conditions that may cause adjustment disorders? (2) Are there certain people who are predisposed toward adjustment disorders? (3) How is it that under apparently similar conditions some people are a success and others a failure? (4) How may adjustment disorders be prevented?

It cannot be said that the results are very startling to anyone who has followed the recent work of industrial psychologists and psychiatrists. By comparison with the adjusted group, the non-adjusted had unsatisfactory family backgrounds, with bad parental relationships; they were out of harmony with their surroundings and found difficulty in facing up to reality. By and large the non-adjusted felt menaced by the outside world and lacked vitality to deal with it. Most of these characteristics, which determined success or failure, were symptoms of which an employer could take account but which he could do little to relieve. On the other hand, management and personnel departments have an important mission to fulfil in recognising and preventing adjustment disorders and this can be helped by co-operation with the factory medical and psychological departments in selection and promotion.

The book concludes with a discussion of the extent to which adjustment disorders are inherent in the nature of industrial conditions themselves, although the author admits that the available material is insufficient to provide a complete answer. Among possible influences the first is the time factor—the rigidity of starting and finishing times and the work cycle; the second is the inability of the individual to expand, to justify his existence and maintain a sense of freedom; the third involves the possibility of

choice of work, the scope for self-development and, on the other hand, the increasing mechanisation, specialisation and monotony of work. While mechanisation may reduce the need of human physical energy and this may be an advantage, it is also a fact that for many muscular persons the need to utilise the muscular strength is essential to their physical and psychic well-being.

The author's conclusion is that the direction in which industry is developing is not favourable to the growth of the individual except at the higher levels or in development and research. The only way to overcome these factors in large-scale industry is by good management and in the promotion of satisfactory personal relations. The question the author leaves unanswered, for reasons apparent in the results of the studies themselves, is whether it is the nature of industrial society or of man's inheritance itself which prevents him achieving this goal.

INDETERMINATE FRAMES

Analysis of Structures: The Analysis of Statically-Indeterminate Structures by the Deformation Method. By M. SMOLIRA. *Concrete Publications, Limited, 14 Dartmouth-street, London, S.W.1.* (18*s.*)

The analysis of statically indeterminate or redundant structures is based on simultaneous satisfaction of the conditions of equilibrium and those of compatibility of strains or deformations. The formal method of setting-up the two sets of conditions from first principles is now rarely used, because various convenient devices for deriving the relevant final equations in general (e.g. energy methods) or for particular kinds of structure (e.g. slope-deflection methods for rigid-jointed structures) have been evolved during the last 100 years. In recent years, attention has been concentrated on methods which avoid the explicit use of simultaneous equations, for example, moment distribution and the more general—though allied—method of relaxation of constraints. And now the programming of digital computers for structural analysis has revolutionised the process for complicated structures, the only manual activity involved is that required for the preparation and input of data.

Viewed against this background, Dr. Smolira's book, the purpose of which, he states, is " . . . to give in handy form time-saving methods of analysing continuous frames . . . ", appears to be of a reactionary nature. It deals with what is the inversion of the slope-deflection method for rigid-joined frames in which only flexure of members is significant. Instead of beginning by setting-up the equations of equilibrium in terms of angular deformations, the equations of compatibility of angular deformations are derived in terms of the loads and internal bending moments (using flexibility coefficients). These equations are then solved simultaneously, taking account of the conditions of equilibrium. The process is called the " deformation method " by the author but the principle of the method is not new, because for analysis of any statically indeterminate structure there are always the two possible approaches. Using this method the final simultaneous equations are often set up rather more easily than by the slope-deflection method, though they are usually more numerous if the number of displacements of joints is less than the number of redundancies.

In the five chapters of the book the author applies the method to statically indeterminate beam systems, portal frames with pinned feet and thin rings, continuous frames with pinned feet, Vierendeel trusses, and the determination of equations of influence lines.

A fundamental weakness of the book is what seems to be an attempt to distract attention from or even to disguise the conditions of equilibrium of forces and moments, which, as stated above, are as vital for this as any other method of analysis. The conditions for the equilibrium of moments at the joints are used by the author in his writing of the compatibility equations, and additional equations are obtained by considering " shearing conditions " with reference to the horizontal components of the applied loads and the horizontal reactions at the column feet of frames. Unfortunately, vertical reactions appear to be ignored completely at the expense of errors in the so-called shearing conditions when the columns are inclined (e.g., page 35 equations 82, and page 43 equations 95); furthermore, the shearing conditions for Vierendeel trusses with inclined chords (chapter IV) are incorrectly written.

The book is quite well designed and the diagrams are clear, and there is no doubt that some readers will find it novel and stimulating. But its faults make it difficult to recommend the work for use by students and others who may not be able to discern its shortcomings.

CREDIT FOR A GOOD CROP

Atom Harvest. By LEONARD BERTIN. *Secker and Warburg, Limited, 7 John-street, London, W.C.2.* (20*s.*)

In his *Report on the Atom* Mr. Gordon Dean, former chairman of the U.S. Atomic Energy Commission, wrote: " Under no circumstances can it be said that the atom is a native-born American. The most that can be said is that it is an immigrant of mainly European lineage that has taken out its first papers here." Mr. Bertin here sets down the names of those European scientists who provided the theoretical background to the most influential technological development the world has so far known, and he describes in breezy, journalistic fashion, with many sketches of the personalities involved, the history of Britain's own achievement in the ten years which passed from the end of the war when we had nothing at all to the Government announcement to spend £300 million on reactors for the generation of electricity.

He clearly feels very bitter about the breakdown in full co-operation which occurred in 1942 when the Americans decided to restrict exchange of information to individuals who needed it solely in the furtherance of the war effort. This amounted to a refusal to hand over any " know-how " about the technological problems involved in the design of reactors, and the production of fissile material, and forced Sir Winston Churchill to sign the Quebec Agreement which left to the discretion of the President of the United States the degree to which information of value for industrial purposes should be disclosed after the war. In the event the McMahon Act prevented any information being passed over at all, and the rest of the world—allies and enemies, members of the free world and iron curtain countries alike—had to start from scratch.

However, the fact that this new technology was based on the published discoveries of half a century, made by scientists in a dozen different countries, meant that any country with an advanced engineering industry which could afford the gigantic resources required could build an atomic energy industry and make atomic weapons, although this was not acknowledged until the Geneva Conference last year when the barriers to knowledge at last began to come down.

It is often forgotten what a large part French scientists played in this development. They were the first to take out patents for chain-reacting piles before the war and a large number of them were smuggled out of France in 1940 together with 36 gallons of heavy water. These scientists, together with the many Jews Hitler drove from Germany and Mussolini from Italy and scientists who later escaped from other occupied territories, joined their British and American counterparts in the research work which finally led to the first atomic bomb and all that has followed from it. This appears to be a supreme example of the oft-stated fact that Europe excels in pure research and lets America reap the rewards in industrial development; and yet the achievement of the relatively small group of engineers who, starting in the difficult conditions of Britain immediately after the war, brought our programme to fruition is beyond compare and Mr. Bertin has done well to give to so many of them by name the credit which is their due.

It is no doubt strictly true that, given the necessry data by the physicists and chemists, design and construction of reactors, of plants for the reduction of uranium ore and for the separation of fissile material, is straightforward engineering work which only needs adequate resources to carry it out, but the mind of the average engineer boggles at the problems that had to be solved and the risks that had to be taken, if the Monte-Bello explosion was to take place within the time limit set for it. Of the 13 men who first met at Risley to start the production division only one, who had been in Canada, knew anything about atomic energy. The design of the plutonium extraction plant at Windscale worth £20 million had to be done on the basis of experiments with 0·025 gramme of plutonium and without the construction of a pilot plant. The first big experimental reactor Bepo consisted of a cube of graphite of a hardness never previously machined, containing 28,000 blocks, and the whole had to be assembled within a tolerance of 0·015 in.

The uranium separation plant had to be designed to operate under conditions of cleanliness, automatic control and safety unheard of in plants of such a size. The correct behaviour of employees while working under these conditions, where a single mistake could ruin the process or cause appalling injury from radio-activity, had to be carefully built up. At Windscale this was done by building a " mock-up " plant, manufacturing ammonium nitrate and pretending that it was radioactive. It was then operated and maintained under these simulated conditions. Above all it has been a human achievement owing a great part of its success to the quality of human relations built up by the men who were the leaders of its several divisions.

What of the future? The Atomic Energy Authority and the Government have a difficult choice to make. The official programme is still to build a number of reactors of the Calder Hall type—popularly known as " Model T." Because of our urgent need for more sources of energy and because these plants can be easily duplicated at reducing costs so as to generate electricity at a cost comparable with coal or oil-burning plants, it is argued that we should concentrate on them. On the other hand, the gift of the United States to other countries of enriched uranium may enable them to jump ahead in the design race to the detriment of our export chances. The question must to some extent depend on the availability in this country of fissile material which is a closely guarded secret. Mr. Bertin attempts some calculations about this and arrives at the conclusion that the yearly production rate of plutonium at Windscale alone is sufficient for more than 50 bombs and this takes no account of the production of Uranium 235 at Capenhurst. It looks as if the situation ought shortly to be reached where some of this material could be made available for use in more efficient reactors.

There is a danger that research and development work and the design of experimental reactors may be held back by the shortage of trained staff and, in particular, design engineers. Some of these are now being attracted to the four combines which have been formed by private industry to manufacture plants. It would be a tragedy if the history of the aircraft industry were to be repeated and too few people be spread too thinly over too many projects. It would appear that the right policy is for the A.E.A. to concentrate on the research and the development of new types of reactor and for the firms to concentrate on construction. The decisions to be taken are of such magnitude and will have effects over such a long period that they compel consideration at the highest levels of policy making.

NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

Proceedings of the Seventh British Electrical Power Convention, 1955. *British Electrical Power Convention, Eastcastle-street, London, W.1.* (12*s.* 6*d.*)

This is a complete account of the proceedings at the seventh British Electrical Power Convention, held at Brighton last year, including the Presidential Address (by Sir Harry Railing), the papers read and the discussion thereon. The annual report of the Council and a list of delegates and visitors attending are also included.

Electrical Trades Directory, 1956. The Electrical Journal Blue Book. 74th edition. *Benn Brothers, Limited, Bouverie House, 154 Fleet-street, London, E.C.4.* (63*s.*)

The seventy-fourth edition of this well known reference book contains some 65,000 entries under the headings of manufacturing and other companies; merchants, exporters, importers, agents and patent agents, electrical installation contractors, wholesalers and distributors; twenty-seven different categories of engineers; information regarding electricity supply and transport; institutions, societies, colleges, schools and institutes; Government and municipal departments; personal; products and materials; and trade names. The latter includes more than 5,700 names of patented and branded articles, accompanied by the names of the makers. Four major groups of manufacturers undertaking the production of nuclear power generating plant and equipment are listed.

The British Shipbuilding Compendium. The Buyers' Guide to British Shipbuilding, Marine Engineering, Repairing, Ship and Shipyard Equipment. Sixth edition. *The Shipping World, Limited, Effingham House, Arundel-street, London, W.C.2.* (20*s.*)

The prime purpose of this book is to list the British companies which supply the various materials and items of equipment that go to make a ship. In order to provide a complete book of reference to the shipbuilding and allied industries, shipbuilders and ship repairers are also included. This edition also devotes a separate section to shipyard equipment. An alphabetical index to firms is given at the end of the book.

The following reports may be obtained from the British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey:

The Effect of Dipoles on Electric Strength. By H. PELZER. No. L/T320. (7*s.* 6*d.*) The report produces evidence showing that experimental findings about the intrinsic electric strength of high polymers can be explained by the influence of dipolar groups on electron scattering, if the dipoles are assumed to scatter independently.

Improvement of Line Regulation by Series Capacitors. By S. SILBERMANN. No. Q/T128. (12*s.*) The report gives methods of calculating the performance of capacitors connected in series with overhead transmission lines with a view to improving the regulation. The advantages and disadvantages of the method are discussed.

Corrosion of Internal Tank Surfaces in Non-Conservator Transformers. By M. WATERS. No. Q/T130. (10*s.*) A summary of the existing knowledge on the corrosion of the internal surfaces of transformer tanks, based on replies to a questionnaire issued to manufacturers and users of transformers. Experience seems to indicate that where acidity is not due to excessive temperatures, the cause must be sought in the presence of powerful catalysts in the oil, usually as part of the materials making up the transformer. Suspicion seems to rest upon the varnishes which are used for impregnating the windings, particularly when they are not completely covered or when all the solvent has not been removed.

The Effects of Dissolved Gases in the Design and Operation of Oil Immersed Transformers. By M. R. DICKSON. No. Q/T139. (18*s.*) A review of the published information on the solution of gases in transformer oil with their effects on the properties of the oil.

Station Protection by a Length of Cable. By R. DAVIS. No. S/T62. (15*s.*) An attempt to assess quantitatively the performance of a cable (connected between a terminal station and overhead line and behaving as a surge protective device), in reducing the frequency and severity of overvoltages produced by lightning discharges to the overhead system.

Bridge for the Measurement of the Admittance of Electrical Insulation at Very-Low Frequencies. By G. MOLE and D. C. G. SMITH. No. V/T116. (12*s.* 6*d.*) A new form of bridge network in which the criterion of balance for measuring insulation admittance at very low frequencies is that the voltage across two of its branches are in quadrature. The bridge thus measures the shunt capacitance and shunt conductance of insulation independently, with one side solidly earthed. It is suitable for testing specimens of capacitance from 10 picofarads to 1 microfarad over a frequency range from 50 megacycles to 150 cycles and has a specimen lead 30 ft. long.

The Principles of Argon-Arc Welding Aluminium. Prepared by P. T. HOULDCROFT. *British Welding Research Association, 29 Park-crescent, London, W.1.* (2*s.* 6*d.*)

The first of a series of booklets on the argon-arc welding of aluminium and its alloys deals with the principles of the process and gives an account of the essential features of argon-arc welding and its practical use and application. Among the subjects covered are: keeping the arc going, balancing the current output, the correct arc length, handling the filler rod, and argon economy. A bibliography of over 60 references is included.

Shop Mathematics. By CLAUDE E. STOUT. *John Wiley and Sons, Incorporated, 440 Fourth-avenue, New York 16, N.Y., U.S.A.* (3.75 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (30*s.*)

This book has been designed to give the student or shop employee those fundamentals of mathematics essential to his work. It is arranged in four parts to meet the needs of a training programme for machinists, tool and die makers, and pattern makers. Basic principles of arithmetic, algebra, geometry, trigonometry, logarithms, and the slide rule are included, together with many valuable applications. Emphasis upon accuracy of computations is stressed throughout. Methods of checking most operations are given.

Refining Antimony by Electrodeposition and by Distillation. By R. R. ROGERS and R. A. CAMPBELL. Technical Paper No. 11. *Department of Mines and Technical Surveys, Mines Branch, Ottawa, Canada.* (25 cents.)

The research described in this Technical Paper was undertaken to supply a quantity of high-purity refined antimony to the Physical Metallurgy Division of the Mines Branch. The authors refined antimony on a large laboratory scale by distillation, electrodeposition, and a combination of these two methods. The best grade of material produced contained 99·894 per cent. of antimony, and, in addition, a considerable amount of new information regarding the metallurgy of antimony was obtained during these experiments.

Plastics for Corrosion-Resistant Applications. By RAYMOND B. SEYMOUR and ROBERT H. STEINER. *Reinhold Publishing Corporation, 430 Park-avenue, New York 22, N.Y., U.S.A.* (7.50 dols.); and *Chapman and Hall, Limited, 37 Essex-street, London, W.C.2.* (60*s.*)

The aim of the authors of this work is to supply engineers with the data necessary to select the plastic most fitted for use in a particular corrosive environment. The subject matter is divided into five main sections respectively entitled: general information on plastics, plastic materials of construction, thermoplastic applications, plastics in masonry construction, and plastics selection guide. Wherever possible, information regarding the chemical resistance of coatings, linings, pipe, and reinforced or thermoplastic structures are compared in tabular form to enable the most suitable material to be chosen.

Boiler Plant Technology. By R. L. BATLEY and E. GORDON BARBER. Third edition. *Sir Isaac Pitman and Sons, Limited, Pitman House, Parker-street, London, W.C.2.* (25*s.*)

This book embodies the results of research made co-operatively by an engineer and a chemist, and is designed to appeal to those interested in obtaining and maintaining the maximum operating efficiency in the boiler plant under their control. In the present edition a number of recent developments have been taken into account, a chapter on automatic boiler control has been added and one on refractories has been deleted. A good deal of revision, especially as regards materials of analysis and testing, has taken place.

The History and Development of Cycles as Illustrated by the Collection of Cycles in the Science Museum. Part 1: Historical Survey. By C. F. CAUNTER. *Science Museum, South Kensington, London, S.W.7, and H.M. Stationery Office, Kingsway, London, W.C.2.* (4*s.*) (Reviewed on page 240.)

Success and Failure in Industry: A Psychomedical Study. By DR. M. R. VAN ALPHEN DE VEER. *Van Gorcum and Company, N.V., ...en, Netherlands.* (13.50 Dutch florins.) (Reviewed on page 240.)

Analysis of Structures: The Analysis of Statically-Indeterminate Structures by the Deformation Method. By M. SMOLIRA. *Concrete Publications, Limited, 14 Dartmouth-street, London, S.W.1.* (18*s.*) (Reviewed on page 241.)

Atom Harvest. By LEONARD BERTIN. *Secker and Warburg, Limited, 7 John-street, London, W.C.2* (20*s.*) (Reviewed on page 241.)

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given though distribution is sometimes restricted.

Helical Membrane Cable. THE TELEGRAPH CONSTRUCTION AND MAINTENANCE CO., LTD., Mercury House, Theobalds-road, London, W.C.1. A new high-power feeder capable of carrying 20 kW at 100 megacycles. Characteristic impedance 50 ohms. Central copper conductor supported within a tubular outer conductor of aluminium by a helical edge-on tape of polythene. Overall diameter 3⅛ in. Intended for television transmitter aerial feeders. Technical paper.

Rubber. THE NATURAL RUBBER DEVELOPMENT BOARD, Market Buildings, Mark-lane, London, E.C.3. The use of rubber in many industries: road making, upholstery, heavy-duty couplings, motor trade, protective clothing, castings and moulds in all patterns; the properties and use of ebonite. Illustrated booklet entitled "Rubber Developments."

Hydraulic Compressor for Overhead Electric Power Line Joints. THE ENGLISH SALVI CO. LTD., 11 Kensington Church-street, London, W.8. Details of 10 ton, 50 ton and 100 ton hydraulic compressors, designed for making joints on overhead electric power lines. Illustrated leaflets containing results of tests.

Protecting Steelwork. WINN AND COALES, LTD., Denso House, Chapel-road, London, S.E.27. "Denso" products for the protection of structural steelwork, pipework, electrical equipment, etc. In particular, aluminium-painted tapes which can be formed to profiles of work; held in position by Denso paste. Illustrated booklet.

Electrical Transmission System. GEORGE KENT, LIMITED, Luton. Electrical systems for transmitting, over a distance, the measurement of flow, level and similar functions. Details of transmitters, receivers and communicating circuits. Illustrated pamphlet No. 966/1155.

Flameproof Motors. LANCASHIRE DYNAMO AND CRYPTO LTD., St. Stephen's House, Victoria-embankment, London, W.C.1. Details of Buxton certified flameproof motors and of results obtained at the Buxton Testing Station on a motor of this type running at 3,000 r.p.m. Illustrated leaflets.

Air-Motor Agitator. B.E.N. PATENTS LTD., P.O. Box No. 10, High Wycombe, Buckinghamshire. Agitator for heavy pigments and metallic finishes to prevent separation during spraying. Operated by opposed-piston compressed air motor consuming 2 cub. ft. per min. Leaflet CB 137.

Mechanical Handling. ROBERT DEMPSTER & SONS LTD., Rose Mount Iron Works, Elland, Yorkshire. Mechanical handling plant for coal, coke, ash, ore and other materials. Conveyors, telphers, tippers and ship hoists. Examples shown in 20 page illustrated booklet.

Structural Timber. RAINHAM TIMBER ENGINEERING CO., LTD., Frog Island, Rainham, Essex. Gluad laminated-timber bowstring trusses up to spans of 150 ft.; method of construction permits local reinforcement; fixing shoes incorporated in trusses. Illustrated broadsheet.

Materials Conveyor. GEORGE PIKE LTD., Alma-street, Birmingham, 6. "Jet-conveyor" which will throw such materials as sand, ballast, powders, cereals and rubbish up to 60 ft., at rates up to 60 tons per hour. Illustrated leaflet.

Absestos Lagging. CAPE ASBESTOS CO. LTD., 114-116 Park-street, London, W.1. "Caposite" preformed asbestos lagging for surfaces up to 1,000 deg. F. Data sheets.

Asbestos Textiles. CAPE ASBESTOS CO. LTD., 114-116 Park-street, London, W.1. Varieties of asbestos cloth, yarn and rovings for industrial use; uses and properties. Illustrated booklet.

Crawler Tractor. MARSHALL, SONS & CO. LTD. Britannia Works, Gainsborough. Track-Marshall Diesel crawler tractor, 48 h.p., 12,000 lb. drawbar pull. Full description in publication No. 2943.

The Engineering Outlook—9

CIVIL PLANES CONTINUE TO GET MILITARY AID

AIRCRAFT INDUSTRY APPROACHES COST BARRIER

On the basis of employment, output in the aircraft industry increased by about 5 per cent. between November, 1954, and November,1955. Output statistics for this industry are unsatisfactory since they do not include output of military aircraft, but as shown in Fig. 2 there was a marked rise in the production of civil aircraft from 388 in 1954 to 559 in 1955. Over the next few years the output of civil aircraft is likely to become relatively more important than has been the case recently, since the output of military aircraft is expected to fall on completion of contracts already placed. In the air estimates for 1956-57 provision for expenditure on new aircraft is £21 million below the figure for 1955-56.

R.A.F. REQUIREMENTS

Following the development problems of the last two or three years, 1955 saw a steady increase in production of modern types of military aircraft, including in the fighter field, the Hawker Hunter and the Gloster Javelin, and in the bomber field the V-types, including the Handley-Page Victor, the Avro Vulcan and the Vickers Valiant. Future developments will be concentrated mainly on the Victor and Vulcan.

Apart from Hunters ordered by the R.A.F., some 400 were supplied under the United States offshore purchasing programme as replacements for the Sabre Jet, while over 100 were purchased by the United States Government on behalf of the R.A.F. Continued progress was made during the year in the development of the English Electric P.1 and the Fairey Delta II, both of which have exceeded the speed of sound in level flight, while the latter holds the world air speed record of 1,132 m.p.h. Competition in the field of fighters, however, is likely to become more intense, both from the American and French industries. The latest models of the Super Sabre are believed to be capable of speeds approaching 900 m.p.h., while the Convair F102A is claimed to have overcome the problem of interference drag at high speed by employing a wasp waist design with swept wings placed far back in the body of the fighter. In France the successful Dassault Ouragan has been replaced by the newer Mystère for which there is said to be a ready market within future N.A.T.O. plans. However, the Mystère still has to build up the reputation enjoyed by the Hunter before it is likely to be taken up in very large numbers. The French aircraft industry was successful in securing contracts for trainer aircraft for the Luftwaffe, and a number of Fouga Magister twin jet trainers powered by French Marboré turbo-jets were ordered. The German firms of Messerschmitt and Heinkel will start manufacturing the Magister trainer under licence later this year. In connection with German requirements of trainers it has been stated that only the French and Italian industries were in a position to submit satisfactory modern designs. It was announced, however, during 1955 that F. G. Miles, Limited, are developing a new jet trainer which is expected to be ready for flight trials early in 1956.

The placing of further military aircraft orders for the Luftwaffe will be discussed by the German Government very soon. Germany intends to spend £300 million during the three-year period 1956-59 and in 1956 aims to spend £100 million on new orders. Including trainers, Germany is to have a front-line strength of 1,400 fighters, all-weather interceptors, fighter bombers and transport aircraft, though up to one-half of these requirements will probably be supplied in the form of outright gifts from the United States, and will probably comprise mainly F84 jets. The remainder will be purchased, and at present it is being debated whether the bulk of the orders will be for the Dassault Mystère or the Hawker Hunter. If the decision is in favour of the latter, the resurgence of the German Air Force may go a long way to offset any fall in defence expenditure in this country.

MILITARY EXPORTS

The English Electric Canberra jet bomber continues to be successful in export markets. During 1955 Peru ordered eight Mark VIII Canberras and became the sixth air force to buy these aircraft and the third to do so in South America. Subsequently orders were also received during the year from the Royal Australian Air Force.

There have been important developments during the past year in guided missiles and it was recently revealed that 1,000 test missiles had been fired at Aberporth since the beginning of 1954, while additional tests were carried out at Larkhill on Salisbury Plain. It has been stated that the first air-to-air guided weapons will be delivered during the coming year, and present plans envisage the progressive build-up of a system of surface-to-air guided missiles designed to deal with enemy bombers while out at sea. A production order has been placed for the first of these weapons for Service trials.

With regard to vertical take-off, it was stated last year that besides the "Flying Bedstead" which was developed by Rolls-Royce in 1954, there also exists the PD11, developed by Short Brothers and Harland, Limited. Similar developments have been taking place overseas and in France the Coléoptère is a new design evolved by the Bureau Technique Zborowski in conjunction with the State-owned S.N.E.C.M.A. aero-engine concern. This resembles a sort of "Flying Beetle." The unusual design is reflected by the wings being constructed in one piece in an annular circle round the body of the aircraft. The wing therefore forms what is called an aerodynamic duct having effects both on lift and on thrust. The excess of thrust over weight is said to be far greater than that of the most high-powered fighter, and it is claimed that the aircraft may eventually be able to climb to 50,000 ft. in two minutes and may have a level speed of 1,300 m.p.h. Control is effected by a jet deflector and the advantages claimed include the ability to take-off and land vertically on a small platform. Mr. Peter Masefield, the then Chief Executive of British European Airways, addressing the Town and Country Planning Summer School at Cambridge last August, predicted that the future of civil aircraft lay to a large extent in the development of vertical take-off, though it would seem that for some time at least its use is likely to be confined to military application on grounds both of safety and of noise.

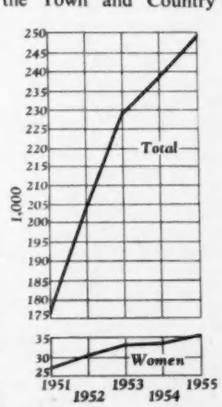


Fig. 1 Employment of men and women in the aircraft industry (manufacture and repair) at November in each year.

Two jet aircraft which can be initially propelled and later boosted by rocket have been developed in this country, namely, the Saunders-Roe SR53 and the Avro 720. These are expected to show exceptional performance as interceptors at high altitudes where the power of the jet engine falls off seriously. Early in 1955 it was announced that both de Havilland and Armstrong Siddeley had developed liquid-fuel rocket motors.

TRANSPORTERS AND AIR-LINERS

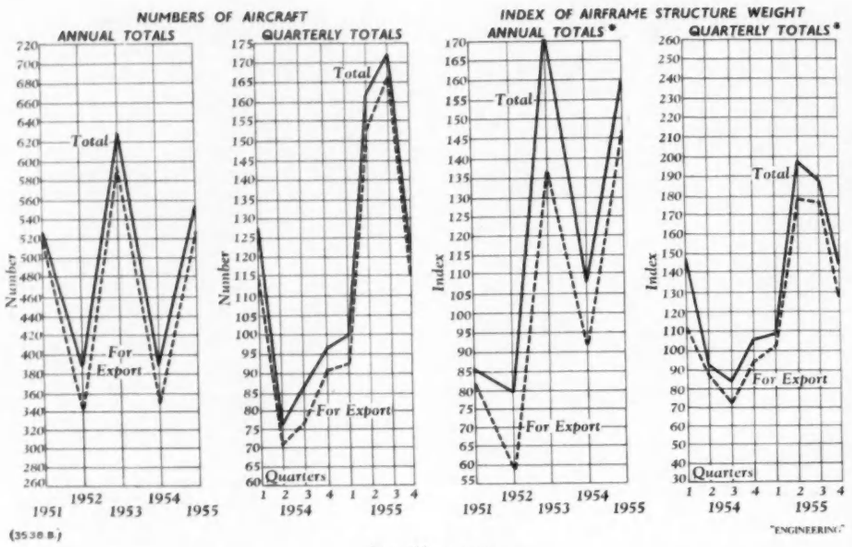
An important development during 1955 was the suspension of further development on the Vickers V 1000 military transport and its civil counterpart, the VC 7. This gave rise to criticism mainly on the score that it would hamper the production of long-range civil aircraft, since to a large extent the successes of the American civil transport planes have depended on the support which the industry has received from the Government. For example, figures recently published show that of a total of 546 home orders for the Boeing Stratocruiser, 500 were placed by the defence department for military purposes. Similarly, while 59 Boeing 707 jet aircraft were sold to civil airlines, 257 were purchased by the United States Government. In the case of the Douglas DC6, the corresponding figures were 312 ordered by civil aviation companies and 220 ordered by the Government, while approximately half the output of both the Convair 240 and Lockheed Constellation was accounted for by Government purchases. As a result of suspension of work on the civil version of the V 1000, British manufacturers are unlikely to be able to put forward any long-range jet aircraft to compete with either the Boeing 707 or the Douglas DC8.

However, it was reported in February, 1956, that discussions were proceeding between Government departments, B.O.A.C. and certain aircraft manufacturers regarding the design of a new jet air-liner with a cruising speed of 550 m.p.h., a range of 5,000 miles and seats for 150 passengers on tourist standard. In the meantime the British aircraft industry will be relying, so far as the larger planes are concerned, on the Comet IV and the turbo-prop Britannia.

BUYING FOR MAJOR ROUTES

In February, 1956, orders for the Britannia stood at 49 airc aft, worth over £50 million including spares, while negotiations were in hand for a further 18. Production is well under way both at Filton and at the works of Short Brothers and Harland Limited, at Belfast. When these lines are built up completely, a joint output of between 50 and 60 aircraft a year is envisaged. B.O.A.C. has ordered 33 of these aircraft, but it is interesting to note that Canadian Pacific have also placed orders for three with an option for five more while El Al of Israel have also ordered three with an option to buy two more. The very high cost of developing an aircraft of this type is shown by the fact that the development and production of the Britannia is stated to have cost £20 million and the Bristol Aeroplane Company will have to sell 80 before it can begin to make a profit. Pending the availability in sufficient numbers of British aircraft, B.O.A.C. have also ordered the Douglas DC-7C, a reciprocating-engine plane which is intended to cross the Atlantic non-stop all the year round and has a projected range of 5,000 miles. Altogether 104 have been ordered, the first batch being due for delivery to Pan American Airways in the summer of 1956. The projected Bristol 187 airliner, designed to carry 130 passengers, will be rather larger than the Britannia and will have four BE-25 turbo-prop engines which each give a take-off power of 6,000 h.p.

In the medium to long-range types of aircraft, the Comet IV, which should be in use by 1959



* monthly averages

Fig. 2 Total production and exports of civil and military aircraft from the United Kingdom. The index of airfame weight is based on 1948 as 100.

or 1960, is probably in a class of its own, though the challenge of the French Caravelle jet air-liner cannot be overlooked. The fact that Mr. Malenkov flew to London in a Russian jet air-liner also cannot be ignored. Despite the fact that the TU-104 has no pressurised cabin, Aeroflot plan to replace the existing piston-engined Ilyushin with the new jet within the next few years. A more formidable competitor to the Comet, however, could be the new turbo-jet Convair Skylark. General Dynamics state, however, that they must have an initial order book of 40 aircraft before going into production. Meanwhile B.O.A.C's orders for Comet IV's are valued at about £36 million, and the successful world tour of the Comet III prototype augurs well for future sales. The Comet IV is powered by the Rolls-Royce RA29 turbo-jet which has a thrust of over 500 lb. and is claimed to show a very low fuel consumption for a given thrust. The Comet IV is built to carry 60 first-class passengers with baggage and freight over a distance of 3,000 miles or 76 tourist passengers over 2,700 miles. The optimum speed is 500 m.p.h. and the Comet should be generally useful for world routes, though in the case of the service between Europe and New York it will need one halt for re-fuelling on the Westbound route.

Another medium-range aircraft in course of development is the turbo-prop Vickers Vanguard, which—though slower than the Comet—will be cheaper both in first cost and in operation, and it will be interesting to see whether it can repeat the success of its smaller predecessor, the Viscount. Mr. Peter Masefield, addressing the United States Institute of Aeronautical Societies at Seattle in August last year, said that 500 of this type of aircraft (medium-range turbo-prop) would be needed within the next 10 years. The most formidable competitor to the success of the Vanguard will probably be the United States Lockheed Electra. It is known that 104 of these aircraft have already been ordered by civil air-lines in the United States and, with sufficient Government backing, they could be delivered before the final completion of the Vanguard project. The latter is provisionally a private venture, though the United Kingdom Government has been discussing with Rolls-Royce the possibility of making some contribution towards the Tyne RB109 turbo-prop which is to be the Vanguard's power plant. The Vanguard will carry 93 passengers and the provisional delivery date is 1959 to 1960. The Rolls-Royce Tyne engine is the first of a new generation of two-shaft high-compression air-screw turbines which will replace the present low-compression units, and should give the Vanguard a crusing speed of 425 miles an hour. The success of the Vickers Viscount continued in 1955. By the end of March, 1956, orders had reached a total of 302 aircraft valued at over £100 million (including spares) of which export orders accounted for about £70 million, while 117 aircraft—valued at 124 million dollars—were sales to North America. Up to March, 1956, some 106 Viscounts had been delivered, valued at about £70 million. The relative importance of the export orders for Viscounts is shown by comparison with the figures for total exports of civil and military aircraft shown in the Table. These

TABLE I *U.K. Exports of Aircraft and Equipment.* (£1,000)

—	1953	1954	1955
Aircraft and parts	42,276	31,403	39,562
Engines	20,337	20,860	22,243
Electrical appliances ..	1,934	2,085	2,279
Tyres (outer covers) ..	422	611	648
Aeronautical instruments ..	1,173	1,152	1,368
Total	66,142	56,111	66,100

amounted to £66·1 million in 1955 (including electrical appliances, tyres and aeronautical instruments). So far 90 Viscounts have been delivered, the estimated value being round £25 million.

GENERAL-PURPOSE AIRCRAFT

In assessing future prospects for the aircraft industry, there is perhaps a tendency to attach too much importance to the more spectacular long-range types. Many of the major world routes have now been fairly fully developed, but there is wide scope for the further development of feeder and cross-country routes. During 1955, therefore, considerable interest was taken in the development of aircraft suitable to replace the ubiquitous Douglas DC3. In America, for example, the General Dynamics Convair 240 and 340 'planes have gained quite a reputation in the past two or three years, the present order book standing at over 700 aircraft. Among developments last year in America was the announcement of a short range transport plane developed by Mr. J. Frye, who, drawing upon the experience gained in his earlier days with the Douglas Aircraft Corporation, has developed a new turbo-prop " workhorse of the air " called the Frye Transport.

In the United Kingdom, this development has been paralleled by the introduction of two similar planes—the turbo-prop Aviation Traders Accountant, and the Handley-Page Herald, powered by four Alvis Leonides Major reciprocating engines. It has been estimated that at least 600 " DC-3 replacements " will be needed in the next 10 years but this may be an over-cautious forecast. Interest in the Handley-Page Herald was reflected by orders for 35 aircraft worth £7 million before the first public demonstration of this machine at the Farnborough Show last September, and the company is now tooled up for a production line of 100 aircraft per annum in anticipation of further orders. Particular interest is said to have been evinced by the United States while the same has been claimed for the Accountant. This latter project is rapidly taking shape and the prototype is expected to make its maiden flight this Spring.

NATIONAL AND INTERNATIONAL CO-OPERATION

The cancellation of the Vickers V-1000 gave rise to a good deal of controversy regarding the future role of the British aircraft industry. It has been argued that the latter cannot hope to compete with the U.S. industry in the production of the larger long-range aircraft, but the main criticism of the British industry has been the dissipation of effort in the development of too many different types of aircraft. This point was emphasised in January, 1956, by Sir Roy Fedden in an address to the Institution of Production Engineers at Southampton. Sir Roy claimed that sufficient money had been spent and time elapsed to give the country 2,000 modern swept-wing fighters and 500 V-class bombers, but actually there were in service under 600 of these fighters and less than 50 V-bombers. In addition those responsible for producing new specifications had failed to give the industry the right leadership. Short and long term projects had been confused. Constructors should be encouraged to put up forward thinking civil-aircraft designs and Sir Roy postulated that contracts be awarded for prototypes and necessary development work and that the Ministry of Transport and Civil Aviation should be given votes for financing the development of these types. Sir Roy also drew attention to the shortage of the right type of man in the aircraft industry. " If this country was going to survive . . . as a great power . . . something should be done about training a greater number of first-class engineers and technologists of ability very quickly indeed. They should also be paid a salary which sufficiently reflects their ability."

While these criticisms are probably to a large extent justified, in the field of aero-engines Britain is probably more advanced than any other country, and exports are likely to increase substantially in 1956 and subsequent years. Both the French Caravelle jet and the Fokker turbo-prop Friendship use Rolls-Royce engines, while the Bristol Orpheus is the designated engine for several NATO light jet fighters, and if orders are placed they are likely to prove substantial. Mention should also be made of the successful development of the Armstrong-Siddeley Sapphire turbo-jet.

In particular, United States interest in British engines as possible alternatives for new United States gas-turbine air-liners is strengthening. There is reason to believe that Lockheed are likely to use the Napier Eland as an alternative engine for the Electra, while Douglas and Boeing have been closely studying the Rolls-Royce Conway by-pass turbo-jet as a possible future power plant for the 707 and DC8 air-liners. Oversea customers would probably welcome the use of British engines in imported American aircraft, since the cost of the engine can be paid for in Sterling and it is often the case that Britain is in a more favourable geographical position for the supply of spare parts.

While plans for co-operation between General Dynamics and the Bristol Aeroplane Company for the construction of a new medium-range jet air-liner embodying the BE-25 engine, appear to have been shelved (the projected Convair Skylark will be powered by four J-79 turbo-jets supplied by the General Electric Company of America), the first flight was made in March by a Convair 340 converted to Napier-Eland airscrew turbines. Convair are said to be interested both in con-

verting existing planes and in using the Eland as a power plant for further developments of the Convair 340 and 440.

Meanwhile, Rolls-Royce Limited and the Boeing Aircraft Corporation have reached an understanding for full exchange of information and joint development of devices for the suppression of noise in jet aircraft. Bristol and the Fiat Company of Italy have also reached an agreement for the installation of Bristol Orpheus jet engines in Fiat G-91 light fighters. Bristol already has NATO orders for 72 Orpheus engines and Fiat complementary contracts for 30 G-91 fighters.

TWO POSSIBILITIES OF THE FUTURE

Meanwhile, developments continue to be reported in the field of atomic aircraft. Recently, the United States Government officially confirmed reports that the United States of America has built and completed ground tests on an engine for an atomic aeroplane. The design is said to be very simple. In this country the Hawker-Siddeley group have been reported as negotiating for a site near Gerrards Cross for a nuclear-power research station, though it was emphasised that any such development would be a long way ahead. However, the United States has already spent about £82 million on the development of a nuclear power unit and Mr. Hall Hibberd, vice-president of the Engineering Department of the Lockheed Aircraft Corporation, has predicted that such an aircraft could be flying within the next 10 years and will pave the way for civil air-liners capable of flying at three times the speed of sound.

Controversy continues on the future development of the helicopter. Mr. Peter Masefield predicted last year that it would probably be 10 years before the helicopter could become a satisfactory commercial proposition. Helicopters are still small, complex and expensive, and at present cannot carry enough payload to cover basic costs. Four problems, he said, must be faced: the problem of size—the helicopter should have at least 50 seats; the speed should be at least 150 m.p.h.; the problem of reliability would have to be overcome by the use of two engines, probably turbo-props; the question of noise would have to be seriously considered, and the take-off rating be not more than 80 db. On the other hand, the Ministry of Supply hinted late in 1955 that the Government was reasonably interested in helicopter development. This was reflected in an estimated expenditure of £4 million on helicopters by the Ministry in the financial year 1955-56 compared with £2·8 million in 1954-55 and £1·1 million in 1953-54. At the present time the high cost of running a helicopter largely precludes its use on civil routes (the cost of a single journey from Waterloo to London Airport is 35*s*. and even then a loss of about 75 per cent. is made, assuming the helicopter carries a full complement).

ATOMIC ENERGY EVENTS REVIEWED

2—DEVELOPMENTS AT HOME AND ABROAD

Continued from page 221

This second article on developments in the application of atomic energy during the last two months deals with a number of international events relating to European co-operation and the availability and distribution of nuclear fuels; various announcements made recently by the United Kingdom Atomic Energy Authority; and the use of nuclear heat for the gasification of coal. In a third article we hope to cover techniques and products developed by private companies which have been made public during the same period.

International.—Recent events in the international field affect the prospects of British and American firms wishing to undertake power-reactor contracts abroad (their plans depend on security relaxation and the availability for sale of nuclear fuels). Problems have also arisen concerning the method of organising European co-operation in atomic-energy matters; this is also related to the distribution of fuel.

CO-OPERATION AND NUCLEAR FUELS

Initially, support for European co-operation was divided between two plans: the Organisation for European Economic Co-operation favoured co-operation within national frameworks; and the "Little Europe" countries (France, Belgium, the Netherlands, Luxembourg, Italy and Germany) proposed co-operation by means of pooling or supra-national action. The crux of the matter was that under the Little Europe plan, the central atomic agency Euratom would establish common ownership of fissile material at every stage, while the O.E.E.C. foresaw no such monopoly of purchase and sale. It is reasonable to suppose that Britain would support free trade in atomic products; the United States, on the other hand, was more likely to be in favour of Euratom. The importance of finding a *modus vivendi* had been underlined by an American offer of 20,000 kg. of uranium 235, which could only be exploited to best effect if some decision were reached. Fortunately, the difference was shelved when at the end of February the O.E.E.C. agreed to appoint a special committee to deal with matters relating to nuclear energy and did in effect recognise the existence of the Euratom project. This recommendation was supported by the Little Europe countries and it seems therefore that both plans will go ahead simultaneously.

More recently, the United States has announced its intention to sell 129 tons of heavy water to six nations for peaceful atomic-energy applications. Britain will receive 50 tons, France 30 tons, India 21 tons, Australia 11 tons, Italy 10 tons, Switzerland up to 7 tons (prices were approximately £10 a lb.). This may have played some part in the U.K.A.E.A's decision to abandon a scheme whereby heavy water and electric power were to be produced in New Zealand from geothermal steam; the cost of the plant had proved to be uneconomic. United Kingdom supplies of uranium are to be supplemented by uranium concentrates from North-West Queensland, Australia, where deposits of an ore of pitchblende associated with allanite (a complex rare-earth deposit of a type which has not hitherto been mined for uranium) are being worked. The U.K.A.E.A. has entered into a contract with Mary Kathleen Uranium Limited (of the Rio Tinto group of companies) to buy the concentrates for a number of years and has undertaken to lend up to £5 million for the project.

The availability of heavy water and nuclear fuels is an important consideration for British firms wishing to sell complete atomic power plants abroad; however, the U.K.A.E.A. has stated on at least one occasion that such materials would be available when the need arose. As suggested in the initial article plutonium may soon be released for power-reactor use.

NEW HARWELL OUTSTATION

United Kingdom.—The Atomic Energy Research Establishment, Harwell, was founded in 1946 and to mark the first ten years of its activity a series of open days is to be held in the week ending June 2.

The Atomic Energy Authority are acquiring two built-up areas on Grove Airfield, near Wantage, as a site for a small outstation of the A.E.R.E. The new outstation is mainly to provide laboratories to allow the Technological Irradiation Group to develop more rapidly. This group, a part of the Harwell Isotope Division, was formed in June, 1955, in order to assist industry in making full use of the large amounts of radioactive material which will become available from the expanding atomic-energy programme. The location of the Technological Irradiation Group at Grove, rather than inside the Harwell perimeter, will reduce the formalities for those who wish to use their facilities. Later the Isotope School may be transferred from Harwell to the new site.

Several announcements have been made concerning atomic weapons. The third series of atomic weapons tests will be carried out with the co-operation of the Australian Government on Monte Bello Islands, where the first test was made in 1952. The test will consist of a tower detonation and it is stated that fall-out will be less than from the 1952 explosion. (The United Nations Scientific Committe has asked all member countries to join in a survey of radioactive fall-out caused by nuclear tests.)

NUCLEAR HEAT FOR MAKING GAS

Processes and Materials.—Tests to investigate the use of nuclear heat to produce gas from coal have begun at the United States Bureau of Mines' Appalachian Experiment Station, West Virginia. These tests, which at present do not actually involve the use of nuclear heat, resulted from discussions regarding the possibility of using nuclear heat in high-temperature chemical processes. Although the Bureau is concerned with several such processes, its immediate interest is in gasifying coal.

Coal gasification is a necessary first step in processes for producing synthetic liquid fuels from coal and in making synthetic pipeline gas from coal. Two experimental units are to be built, both models of possible nuclear-heated units except that they will be heated electrically, and the first of them is already being used for tests The objects of this preliminary work are: to determine suitable materials for constructing such units; to determine their heat-transfer characteristics; and to study other variables.

A further development in America has been the decision to study the feasibility of using the hydrocarbon compound diphenyl as reactor cooling and moderating material. The United States Atomic Energy Commission have announced that a contract has been signed with a private firm, Atomics International, for the construction and operation of an organic-moderated reactor employing this fluid. The reactor, which will be designed to generate 5 to 15 MW of heat, will simulate the conditions of heat transfer, temperature and coolant flow which would exist in a practical power reactor, and will use highly enriched uranium 235 as fuel. Construction should begin this year, and operation is expected to start early in 1957. Organic compounds such as diphenyl, the A.E.C. says, have several potential advantages, among which are low induced radioactivity, low corrosion of fuel elements, and high boiling points—thus permitting high-temperature systems.

FABRICATING FUEL ELEMENTS

Sir John Cockcroft has recently described (Institute of Physics, April 13) how fuel elements are produced for the Harwell research reactor DIDO. The elements consist of enriched uranium alloyed with aluminium and sheathed in aluminium sheets to prevent corrosion by the water of the reactor. Billets of enriched uranium are first melted in a vacuum furnace with aluminium to produce an alloy. The alloy billet is then covered with sheets of aluminium and passed through a rolling mill, so forming a strip a few millimetres in thickness, and automatically pressure welding the sheath to the alloy. The resulting plates are X-rayed to determine the alloy distribution, and then cut and bent to shape. Finally, a number are brazed together with channels between to give a complete fuel element.

Supplementary News.—The United States have announced plans for an atomic powered aircraft carrier of 400,000 h.p.

(*To be continued*)

Fig. 1 Titanium in granular form is pelleted in Manesty machines, the pellets being ideal for feeding mechanically in the melting process which follows.

MELTING AND MANIPULATING TITANIUM

PRODUCTION TECHNIQUES FOR A NEW METAL

Titanium, the newest of the industrial metals, has only become available in commercial quantities within the last year or two, though its existence as a metal has been known since 1790, and a process for extracting it from the ore was developed by Kroll in 1940. The original establishment of production techniques took place in America, but by the end of 1953 Imperial Chemical Industries Limited had pilot plants at work in this country for the production of titanium at a rate of 150 tons a year. By the autumn of 1955 two new I.C.I. plants were in production. One of these, at Wilton, in Yorkshire, is operated by the Company's General Chemicals Division for the production of metallic titanium in granular form by the reaction of titanium tetrachloride with sodium, a process pioneered by I.C.I., and at present the only commercial alternative to the Kroll process. The Wilton plant operates at a designed output of 1,500 tons a year.

At the second of the two plants, at Kynoch Works, Witton, Birmingham, the company's Metals Division melts the granular titanium, casts it into ingots, and prepares the ingots for further manipulation by rolling or drawing to produce sheet, strip, bar, wire and tube. Some of this further processing is carried out at Kynoch Works, some is undertaken in other works operated by the Metals Division, and some is done by other companies using I.C.I. materials.

Titanium has some very desirable properties, ideal for certain applications, and in the aircraft field its use is firmly established. There are many other uses, both potential and actual, for titanium in the engineering and chemical industries, and the application of the metal is expected to spread widely in the future. Like all other materials, titanium has its limitations, some of which may disappear as theoretical and practical knowledge accumulate. Many problems have had to be solved in order to produce titanium at all on a commercial scale and research into the many problems which still exist is continuous. There is every indication that the process of development, which has been faster for titanium than for any other metal in the past, will continue at a rapid rate.

It is unnecessary to say anything here about the useful properties of titanium which make it particularly suitable for its present and future uses. Nor is it necessary to discuss the use-limitations which some of the metal's properties may impose in certain cases. Adequate information about the chemical, physical and mechanical properties of titanium and its alloys can be obtained from numerous sources. Something, however, must be said of certain properties of titanium which affect its manufacture. At ordinary temperatures titanium is covered by a protective film which maintains it inert, but at high temperatures this film dissolves, the metal loses its passivity and reacts with all known refractories. Moreover, at high temperatures titanium is particularly sensitive to combination with oxygen and nitrogen, relatively small quantities of which will embrittle the metal. It then becomes commercially useless, as there is at present no known method of refining contaminated titanium, as can be done with other metals. Other elements such as carbon can also act as contaminants; in fact, one of the essentials is to avoid contamination of any kind if a satisfactory metal is to be produced. It is obvious that titanium cannot be melted in any orthodox furnace.

MATERIAL PREPARATION

Titanium is received at Witton in granular form packed in light-alloy drums, which are stacked by fork-lift truck until required for use. The granular titanium is supplied to Witton in various grades, the grading being based on the hardness of the metal as expressed by Vickers pyramid number. The first stage in the process at Witton is the blending of the various grades of granular titanium according to the finished hardness required. Blending is done by weight, and any alloying elements such as aluminium, tin or manganese are added at this stage as required. The bulk material is then given a thorough mixing in a Gardner double-cone mixer, the uniformity of the mix being of great importance. As a precaution against a possible fire hazard since metal powders are involved, the mixer is flushed with nitrogen before the mixing commences. After mixing, the material is discharged into containers which are lifted by air-hoist to a gantry over a line of Manesty pelleting machines, and there discharged by hand into the hopper of each machine as required.

After pelleting a further precaution is taken to ensure that the mixing is uniform. The contents of several containers of pellets of the same specification are themselves mixed in a cone-type mixer; any segregation which may have occurred during the pelleting is thus averaged out, and the result is an extremely uniform material. A small vibrating screen is installed in the mixer structure, to screen out any powder which may have resulted from the breakage of pellets. This powder is returned

Fig. 2 Titanium melts at 1,660 deg. C., and reacts with all known refractories. It is also subject to contamination in various ways at high temperatures. Melting is carried out in specially-designed electric furnaces with water-cooled crucibles and an argon atmosphere.

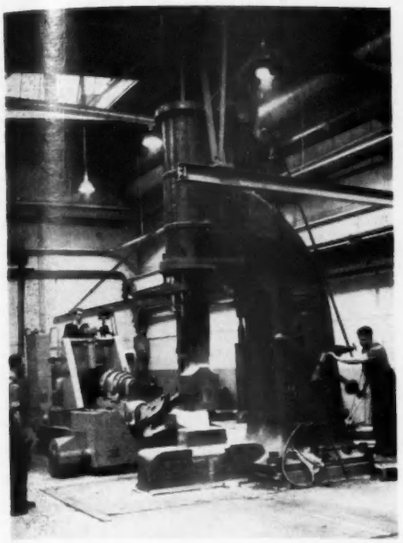


Fig. 3 After casting to an ingot the metal is forged into a slab or bar ready for further processing. Forging is done by hammer or hydraulic press.

Fig. 4 Rolling of the metal is done at present in mills designed for other non-ferrous metals, the rolling technique being varied to suit the material.

to the appropriate pelleting machine for re-use.

MELTING

Although titanium has a high melting point (1,660 ± 10 deg. C.) and copper melts at some 600 deg. C. below this, a copper crucible is perfectly satisfactory so long as it is kept very well cooled with water. The difficult problem of containing the metal while it is being melted has, therefore, been solved by the use of specially-designed electric-arc furnaces with water-cooled copper crucibles.

There are two methods of melting titanium and the first step in each is to evacuate the crucible. This is either left as a vacuum or filled with pure argon gas, since even the smallest degree of contamination by air or other gases during melting would completely spoil the melt.

In the first method, an electric arc is struck between a graphite electrode (mounted in a water-cooled holder) and a small quantity of titanium or titanium-alloy pellets at the bottom of the crucible. When this small quantity has melted, additional pellets are fed in; as these in turn melt, the electrode is raised so that the ingot is gradually built up.

The second method, known as consumable electrode melting, has one great advantage over graphite electrode melting—there is, of course, no possibility of even the slightest degree of contamination by carbon from the electrode, which is made by compacting the titanium powder into a block with the right electrical properties. Where particularly difficult alloys are being handled, it is sometimes necessary to re-melt the ingot in order to be quite certain of a completely uniform product. In such cases, it is often possible to use an ingot produced by graphite melting as a consumable electrode for the second melt.

At present, most of the ingots melted weigh 400 lb., though I.C.I., in the very near future will be producing ingots more than twice as heavy as this.

FORGING AND MANIPULATION

All ingots, whether commercially pure or of alloy, are machined all over to remove surface blemishes. They are then ready for further processing, the first operation being forging to bar or slab. Birlec electric furnaces are installed for heating the ingots to forging temperature, which is from 1,000 deg. C. for commercially pure metal to 1,300 deg. C., for certain alloys. The furnaces have refractory hearths without steel skids, so that there is no possibility of iron contamination of the ingots as they are being heated.

For forging there is a 50 cwt. compressed-air hammer, which usually deals with the round bars, and a 1,500 ton hydraulic press, which is mainly occupied with the forging of slabs. A mobile forging manipulator is provided for use with the hydraulic press. A most interesting feature of the I.C.I. forging hammer is its specially-designed rubber mounting, which is so efficient as a shock-absorber that even a few feet away no vibration at all can be felt. Forging is carried out in much the same way as with other metals, but care has to be taken to see that deformation is not too rapid, and that the layout of the equipment is such that neither time or heat are wasted. Heating of titanium is bound to be attended by certain evils, and as much work as possible therefore should be carried out at each heat. In the forged form titanium and its alloys may be ready for dispatch to customers, in which case all that is necessary is to shot-blast the surface of the forged bars or slabs to remove the small amount of oxide present as a result of heating.

Alternatively, the bars and slabs may proceed to other departments at Witton or to other I.C.I. works for further processing. Sheet, for example, is rolled at Witton from slabs prepared by forging, surface dressing of the slabs being carried out by planing or grinding as required before they pass to the rolling mill.

Rolling, like forging, is on much more orthodox lines at present than melting. Strip, sheet and bar are rolled in mills which were designed for dealing with other non-ferrous metals, the actual rolling technique being varied to suit the material. With moderate tonnages, the existing mills can roll titanium without great interruption to the production of traditional metals, but as output increases, new equipment will be necessary. Indeed, I.C.I. are to build immediately a £2,000,000 plant in South Wales for making all forms of wrought titanium. In this respect, of course, titanium is in the same position as other metals were in the past. Techniques and plant have been evolved to produce large quantities of aluminium and stainless steel, to quote two examples, and there is no doubt that similar developments will take place with titanium as the demand grows. A number of other problems have to be solved, too, among them the question of utilising the scrap arising from the shearing of sheet and strip titanium. At present, only a small proportion of this scrap is recoverable.

COPYRIGHT IN TECHNICAL LITERATURE

PROPOSED CHANGES IN THE LAW

By Anthony Walton

It is not necessary to go as far as those who say that property is theft to see that all property constitutes a monopoly. It is an axiom of modern social justice that suitable restrictions shall be placed on any monopoly, though precisely what such restrictions should be in the case of any given form of property is not always a matter of agreement. In the case of the monopoly conferred by copyright, opinions range between the view that copyright should be perpetual to the view that it should last only 25 years from the date of first publication.

As to what rights copyright should confer (rather than how long it should last) there is the problem how far the owner should be able to restrict all copying of a work in which there is a subsisting copyright. Clearly, he is entitled to protection against copying only part of his work as well as copying the whole. Clearly, too, it would be undesirable that the smallest quotation from his works should constitute an infringement. The practical problem to which these considerations gave rise became in law the problem of whether or not a substantial part of the work was taken. If it was, there was an infringement, if not, not. Before the Copyright Act of 1911 this problem was frequently confused with another problem, namely that of "fair copying." But since that Act the two problems were seen to be quite distinct; it is only after a defendant has been shown to have copied such a substantial part of the plaintiff's work that it would normally constitute an infringement that he needs to rely upon the defence of "fair copying."

This defence was provided in its present form by the Copyright Act of 1911 which provided that "Any fair dealing with any work for the purposes of private study, research, criticism, review or newspaper summary" should not constitute an infringement of copyright. Now whatever the precise interpretation of this enactment, it became clear that it was becoming outdated, in the usual way in which legislation does become outdated, that is by changing circumstances and particularly by technical developments.

PHOTO-COPYING

The exact development which led to outdating in this case was the rise of the art of photo-copying. The student would, under the section quoted, be able to copy parts of works which he required to study in manuscript; he would even be able to copy

such parts photographically—if he had the means at his disposal. But the library might not be able to copy the part for him, because the library might not be making the copy " for the purposes of private study."

In these circumstances the Royal Society made a praiseworthy attempt to by-pass the possible effects of the section by securing general agreement to a Declaration (2nd edition, March, 1952). In fact, 131 bodies had subscribed to the Declaration by 1952 (though they reserved the right to withdraw) thereby representing to the world at large that they regarded as " fair dealing for the purpose of private study or research " the making of copies from their journals (a list of which was appended to the Declaration) under certain conditions. These conditions were as follows: the Declaration applied only to scientific or technical periodicals, and not to books and other non-periodic or non-serial publications; it was assumed that persons requiring a copy had taken all reasonable steps to secure the original journals or separates (though this requirement formed part of the preamble only, and its absence from the main body of the Declaration is considered by ENGINEERING to be a sound reason for not subscribing to the Declaration); the supplying of a copy had to be done by a non-profit-making organisation, such as a library, archives office, museum or information service; only a single reproduction of any one excerpt could be furnished to any one person; only a part of any one issue could be so furnished; the person requiring the reproduction had to state in writing that he required it in lieu of a loan or manual transcription and that he required it solely for the purpose of private study, research, citicism or review; he had to undertake not to sell or reproduce the copy supplied; proper acknowledgement had to be given to the publication from which the copy was made; and the recipient of the copy had to be given notice that he was liable for infringement of copyright by misuse of the copy, and that it was illegal to use the copy for any further reproduction.

That the law of copyright should not be allowed to stand in the way of scientific research is perhaps plain. To the Committee which reported on copyright in October, 1952 (Cmd. 8662) it also appeared that the case of a student of theology or jurisprudence was not different in essence from that of a student of chemistry or electricity, and that it was anomalous that a librarian could save laborious hand copying on behalf of the one but not of the other. This Committee believed that with little modification the arrangements negotiated by the Royal Society were susceptible of general application to any periodical literature without prejudicing the income which either the publisher or author derived therefrom. After discussing the opposing views of librarians and copyright owners, the Committee came to the conclusion that the Declaration should be adapted into statutory rules which should contain as a minimum the following provisions: (1) that the copying was done only by non-profit-making bodies which should be expressly named and specified; (2) that the responsible librarian was satisfied that copies were genuinely required for the purposes of research or private study; (3) that not more than one copy of any one excerpt was supplied to any one person; (4) that the copy supplied did not constitute substantially the whole issue but was restricted to not more than one article; (5) that the excerpts were not supplied at less than cost price (including an appropriate allowance for overhead expenses); (6) that an undertaking in a form to be prescribed was furnished by the applicant that the extract made would not be used for other than its declared purpose.

The Committee considered that these rules should be extended also to the making of extracts from books on the same conditions but with the additional rules that before any substantial extract was taken, application should be made to the copyright owner if known (or if not known to the publishers) for permission to copy, and his permission or refusal would settle the matter. But if the librarian was satisfied that he could not be traced, it would be permissible to copy an extract which did not represent an unreasonably large part of the whole work and was kept strictly to the minimum needs of the reader for the purpose of a particular study.

COPYRIGHT BILL

The views of the Committee have been substantially embodied in the Copyright Bill now before Parliament. Sections 6 (1) and 9 (1) combined repeat the essentials of section 2 (1) (i) of the old Copyright Act of 1911, and section 7 contains the minimum rules for the new law of fair copying. They apply to articles contained in any periodicals, and literary, dramatic or musical works other than periodical publications (i.e., loosely, books). The Association of Special Libraries and Information Bureaux (Aslib) has criticised the limitation of section 7 to books which are literary, dramatic or musical works on the grounds that it is necessary to permit the copying of diagrams or plans which are artistic works. This criticism seems well founded, since the general words of section 9 permit only fair dealing with artistic works, and it is just because " section 7 " copying may not be fair dealing that section 7 is needed. Indeed if, in the case of books, illustrations may not be copied it may also be a question how far the word " article " covers an illustrated article in a periodical, though the intention is no doubt that it should.

But assuming that the work is of a kind covered by section 7 it may be copied under Regulations to be made at the discretion of the Board of Trade, which must however in any event secure that (*a*) the supplying library is of a specified class and is non-profit-making; (*b*) the copies are only supplied to persons satisfying the library that they are required for purposes of research or private study and will not be used for any other purpose; (*c*) no person is furnished with two or more copies of the same article; (*d*) no copy extends to more than one article contained in any one publication; (*e*) persons supplied must pay a price not less than the real cost.

In the case of books, rule (*d*) is not required, but the Board of Trade rules must secure that no copy extends to more than a reasonable proportion of the works in question, and in any event in the case of books no copy can be made if the identity of the owner of the copyright is known to the librarian or could by reasonable inquiry be ascertained by him, without first asking his permission.

Far as these provisions go in the interests of libraries and researchers there have been criticisms, particularly by Aslib, that they do not go far enough. That body wants the research departments of industrial firms to have the right to copy, and suggests that a library should not be deemed to be profit-making solely because it is owned or operated by a profit-making body. It also wants rule (*e*) deleted on the grounds that the other restrictions prevent unfair competition already. It suggests that the rules relating to books should be brought into line with the rules relating to periodicals, and that since the authorised copying of books is limited in extent it should not be conditional on the owner's consent.

It is doubtful whether the Aslib amendments will be accepted. It may be thought that the Bill has already made sufficient encroachments upon the rights of copyright owners. Even as it stands it goes far beyond the Declaration, which was presumably the widest extent to which even a limited number of owners were prepared voluntarily to surrender their rights in the interests of the community.

Further rules may and must be made by the Board of Trade, but such rules can only further restrict the right of copying given by the Bill; in no case can they enlarge it as suggested by Aslib or at all. However they may safeguard owners further. For instance, there is nothing in the Bill to provide that persons requiring copies shall take all reasonable steps to secure original journals or separates. The Board of Trade rules could so provide, though as rule (*e*) seems intended to provide an equivalent safeguard it is not unlikely that they will. But such a rule is desirable, and not unfair, for if the article was in fact available from the owner no research or study would be prevented on the one hand, and on the other the owner could make his legitimate profit. Tear sheets, reprints and the like are usually cheaper than photo-copies.

Again the Bill goes further than the Royal Society Declaration in that it requires only that the person requiring the copy shall satisfy the librarian that it is required solely for the purposes of research or private study; there is no requirement that there must be a written statement of bona fides and an undertaking not to misuse the copy (even though this was also recommended by the Committee); there is no requirement that proper acknowledgement has to be given to the source; there is no requirement that the person requiring the copy should be issued with a warning notice against misuse or further copying.

To sum up, it appears that the Bill has gone as far as it ought to go in removing restrictions in the way of study and research. It ought perhaps further to be provided and made plain that illustrations can be copied under the Bill whether they are in books or periodicals. Other than this the Bill may have gone too far. Certainly copyright owners cannot be expected to welcome the amendments suggested by Aslib, and indeed are entitled to press the Board of Trade to incorporate in the rules it will have eventually to make, some at least of the old requirements of the Royal Society Declaration.

Hubs treated by the EFCO-Udylite bright nickel-plating process; the two on the right by the new No. 514 process and the two on the left by the older No. 31 process.

BRIGHTER NICKEL PLATING

After carrying out a series of exhaustive tests, the Electro-Chemical Engineering Company, Limited, Queens-road, Weybridge, Surrey, have launched a new bright nickel-plating process to which they have given the name EFCO-Udylite No. 514. The process, it is stated, was introduced in the United States a few months ago and its principal advantage over the older No. 31 process of the same name is that the solution employed gives an exceptionally wide bright-plating range and improved line-filling or levelling properties, in other words, the deposit minimises the effects of small irregularities in the base-metal surface. It is pointed out that an important saving in polishing and handling time is realised since the maximum brightness is attained, and, moreover, that the process is particularly advantageous for recessed articles which are notoriously difficult to plate brightly.

The new bright nickel-plating solution is prepared by adding three " brightening agents " and one " anti-pitting agent " to a basic solution containing nickel sulphate, nickel chloride and boric acid. For the continuously successful operation of the process, it is emphasised that it is very important that the concentration of each component of the solution should be maintained at its correct value. The nickel sulphate is the principal source of nickel ions and the nickel chloride enables the anodes to dissolve correctly without polarisation and also improves the conductivity of the solution. The boric acid content stabilises the *p*H value and adds brightness and ductility to the deposit.

No details of the composition of the brightening agents are available for publication; they are

designated as Nos. 41 and 2RL and the anti-pitting agent as No. 22, the last named being supplied in liquid form. A temperature of from 130 to 150 deg. F. (the optimum being 140 deg. F.) is recommended for the best overall results. The average cathode current density is relatively high, namely, between 20 and 40 amperes per square foot, and the anode current density between 20 and 30 amperes per square foot.

A variation of process No. 514 is also available. This, which is designated No. 514H, is recommended for use with copper-plated zinc-base die castings where a high resistance of the solution to zinc contamination is of importance. The 514H solution is also of value as a general purpose electrolyte in automatic plating plants where its high permissible cathode-current density will permit specification plating to be carried out in comparatively short process times.

ENGINEERING AT THE UNIVERSITY OF ST. ANDREWS

RESIDENTIAL, ACADEMIC AND TECHNICAL FACILITIES

It has been reported that while some university engineering departments can accommodate only a small fraction of the applicants they interview, others find it difficult to fill the places that are available. This anomaly must clearly mean a maldistribution of students of university calibre, and in view of the increasing demand for technologists it is a tendency that should be corrected. It may be partly due to lack of information as to the facilities offered—some English schoolboys are not aware, for example, that they can study in Scottish universities—and also to the remoteness of certain establishments from centres of population. From time to time we hope to publish articles on university and polytechnic engineering departments to help in making their facilities more widely known, and in this article we propose to describe the Queen's College School of Engineering in the University of St. Andrews. Queen's College is situated at Dundee, which has a limited local industrial population, and therefore recruits its students from a wide catchment area. It is also an establishment which, in spite of extensive facilities, is not adequately known in the south of England where the demand for places so much exceeds the supply. The article includes some background notes on the departments and the university, a description of the residential, academic and technical facilities provided, and an outline of the courses offered to students.

HISTORY AND BACKGROUND

Founded in 1880, University College, Dundee, was united with the University of St. Andrews in 1890. The union was dissolved in 1895 but reconstituted in 1897, since when the college has formed an integral part of the University. Recently, however, the University has been completely reorganised so that Queen's College, as the Dundee foundation is now called, plays an equal part with St. Salvator's College at St. Andrews.

The main lines of education at Queen's College are pure and applied science, medicine, law, and the social sciences, and in the latter there are new chairs of history, economics and philosophy. The total number of students in the University is a little over 2,000, of whom over 800 are in Queen's College.

Queen's College is situated in pleasant surroundings on the estuary of the River Tay and has well equipped and comfortable student residences. There is the usual range of extra-mural activities with good facilities for golf, while there is also a yacht club in the neighbourhood. The town environs offer considerable scope for walking excursions and ski-ing is a popular activity in the Highland glens in winter.

The College has long been linked with engineering science and the chair of engineering was one of the first to be established there. In 1882 Professor (later Sir Alfred) Ewing was elected its first occupant, and held the chair until 1890 when he went to Cambridge. In 1910 the Peters Electrical Engineering Laboratory was completed and in 1913 Sir Alexander B. W. Kennedy opened the laboratories for civil and mechanical engineering which are illustrated in Fig. 1. The Watson Watt Chair of Electrical Engineering was founded in 1947 and in 1950 the University Grants Committee gave approval for the construction of a new building to be shared by the departments of electrical engineering and botany. These laboratories, known as the Ewing Building and shown in Fig. 2, were opened by His Grace the Duke of Hamilton, Chancellor of the University, on February 12, 1954. (ENGINEERING, vol. 177, page 232, 1954).

Fig. Civil and mechanical engineering laboratories of Queen's College, Dundee. Queen's College as recently been established as a constituent college of the University of St. Andrews.

Fig. 2 Main doorway of the Ewing Building completed in 1953. It houses the Electrical Engineering and Botany Departments and includes laboratories and lecture theatres.

The School of Engineering has recently been elevated to the status of a separate Faculty of Applied Science, and provides courses for students wishing to proceed to the degree of B.Sc. in civil, electrical or mechanical engineering.

CURRICULA

In order to ensure a sound foundation in scientific principles, the first year's work is common to all students, while in the second year, though the same approach generally applies, students of electrical engineering receive some special preparation for their third year. Successful completion of the third-year course, which is moderately specialised, leads to an ordinary degree. Candidates for honours degrees are required to continue their studies for a fourth year during which they specialise in their chosen branch of engineering. Third and fourth year courses in electrical engineering are also included in the curriculum for the honours degree in applied physics.

The accompanying table indicates the range of

Courses of Study for First Three Years

1st year	2nd year	3rd year
Mathematics	Mathematics	Mathematics
Dynamics	Strength of Materials	Theory of Structures (C) (M)
Properties of Matter	Heat Engines	Hydraulics (C) (M)
Heat	Hydraulics	Constructional Eng. (C)
Light	Theory of Machines	Surveying (C)
Sound	Engineering Design	Engineering Design (C) (M)
Electricity	Plane Surveying	Geology (C)
Magnetism	Laboratory	Heat Engines (M) (E)
Chemistry	Principles of Electrical Eng. (C) (M)	Theory of Machines (M) (E)
Descriptive Engineering	Electrical Eng. Lab. (C) (M)	Electrical Circuits (E)
Mechanics	Elements of Electrical Eng. (E)	Electrical Machines (E)
Engineering Drawing	Electrical Measurements (E)	Electronics (E)
Practical Work	Electrical Eng. Lab. (E)	Laboratories

NOTE:—Items represent subjects not actual courses; for example, in the third year both civil and mechanical engineering students take a course in engineering design, but not the same course. The letters C, M, E in brackets after an item indicate that the subject is in the curriculum of civil, mechanical or electrical engineering students respectively; where no letter appears the item is common to all three branches.

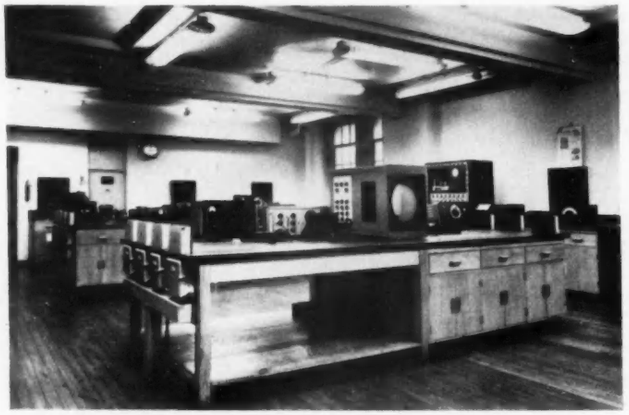


Fig. 3 Both the electrical engineering and applied physics honours degree courses include advanced tuition in electronics, for which there are well appointed laboratories and research facilities. Apart from the main electrical laboratories, there is a high-tension laboratory in a separate building.

Fig. 4 The practical study of electrical machines and power systems is carried out in a well equipped laboratory designed specifically for its purpose. Slotted machinery beds, an extensive power supply system, and overhead cranes simplify installation of plant and experimental testing.

subjects studied during the first three years, showing the specialisation in the three main branches for the ordinary degree. For an honours degree, the student must complete a fourth year in which he is required to pursue advanced studies in two approved honours subjects appropriate to the branch of engineering which he professes in his final examination for the ordinary degree, together with an approved course in mathematics.

It should be noted that a student may change from pure science to engineering or from engineering to pure science at the end of his first year of study, and the time-table for the second, third and honours years is so arranged that students may attend short courses, of one lecture a week, in arts and social science subjects. These courses are designed specially for engineering students in order "to stimulate an interest in the wide field of human affairs which is essential to an engineer in a position of senior responsibility." Developments are also envisaged in which engineering students may take more extensive courses in the new School of Social Sciences, in order to prepare them for careers in production and management.

INSTITUTION REQUIREMENTS MET

The ordinary and honours degree in Civil Engineering and in Mechanical Engineering secure the exemption given for degrees of British Universities from the examinations of the corresponding Senior Institutions. In addition, since the ordinary degree qualifies for exemption from Part I and Part II of the examinations of the Institution of Civil Engineers, the fourth year honours course in Civil Engineering is recognised as a year of post-graduate professional training.

The ordinary and honours degrees in Electrical Engineering, and the honours degree course in Applied Physics, carry exemption from Parts I, II and III of the examination for associate membership of the Institution of Electrical Engineers. The course in Applied Physics provides a sound foundation in physics and mathematics (in which the ordinary B.Sc. is obtained as part of the programme), and electrical engineering (including electrical machines) prior to the fourth year in which the student attends the advanced courses in electrical theory and electronics offered by the electrical engineering department. Students need not decide to take the course until the end of their second year in pure science.

DETAILS OF COURSES AND FEES

Research students in engineering who are graduates of St. Andrews or other recognised universities, can obtain the Ph.D. degree for supervised research, the period required usually being three years but in exceptional cases this can be reduced to two, and a student may be permitted to prosecute his research outside the University for part of the period. The degree of D.Sc. in Engineering is a higher research degree, for independent work involving a substantial contribution to knowledge, open to engineering graduates of the University and members of the teaching staff.

The inclusive fee for the Ordinary Degree of B.Sc. in Engineering is £119 14*s.* payable in three annual instalments of £39 18*s.* For the Honours Degree the inclusive fee is £133 7*s.*, payable in four annual instalments of £33 6*s.* 9*d.* An increase of these fees is likely in the near future. The inclusive residence fee for men, for the three academic terms, is £120 for a shared room and £125 for a single room.

Although it is impossible in a short article to provide a full picture of the syllabus in any one branch of engineering, some indication of the degree courses can be given by selecting a few items from the third and fourth year programmes in each field. For example, the course in theory of structures for the third year includes the subjects of strain energy, Castigliano's theorems and moment distribution methods; the third year heat-engine course deals with such topics as gas and steam turbine theory, refrigerating machines and exhaust-gas analysis; while among the items in the third-year course on electrical circuits are network theorems, transmission lines and power systems, harmonic analysis, pulse techniques, micro-waves, wave guides and radio propagation in the earth's atmosphere. In the fourth year, students reading fluid mechanics cover such problems as viscous flow, theory of lubrication, boundary-layer theory, cavitation and models. In the course on theory of machines some of the subjects treated are free and forced vibration, dynamic-stiffness methods, the gyroscope and automatic control systems. The electronics course includes work on transmitters, vacuum tubes, radio-location systems, ultra-high-frequency techniques and servo-mechanisms.

LABORATORIES AND EQUIPMENT

Effectively the Faculty of Applied Science has two engineering departments, one, under Professor J. Dick, B.Sc., Ph.D., M.A., M.I.Mech.E., devoted to civil and mechanical engineering, the other, under Professor E. G. Cullwick, O.B.E., M.A., D.Sc., M.I.E.E., M.A.I.E.E., F.R.S.E., to electrical engineering, with active participation by the Departments of Mathematics, Chemistry, and Physics. As can be seen from Figs. 3 and 4, which show two of the electrical laboratories, the Electrical Engineering Department is particularly up to date and well equipped. The building itself has been specially designed for its purpose and the foundation of the power laboratory is independent of the surrounding structures; large doors and overhead cranes make it easy to instal heavy items of machinery. Fig. 3 gives an indication of some of the electronics facilities, while an impression of the main electrical power laboratory can be obtained from Fig. 4. There is also a high-tension laboratory in a separate building.

The work of the Department of Civil and Mechanical Engineering covers applied mechanics, strength of materials, theory of structures, theory of machines, vibration, hydraulics, heat engines, soil mechanics, concrete technology, surveying, geometrical and mechanical drawing, design, and allied subjects; and the laboratories are equipped accordingly. Items of equipment added in recent years include 200 ton, 150 ton and 10 ton tensile testing machines; a Pelton wheel, a Francis turbine and a Kaplan turbine complete with dynamometers; a centrifugal pump; a 15 h.p. fan for air flow in ducts;

Fig. 5 The Civil and Mechanical Engineering Department includes a heat-engine laboratory (illustrated), and laboratories devoted to the study of hydraulics, strength of materials, theory of machines, concrete, soil mechanics, structures, vibration and allied subjects.

equipment for reinforced and pre-stressed concrete; soil-mechanics apparatus; modern surveying equipment; a variable compression engine suitable for both spark and compression ignition and equipped with all necessary measuring apparatus; a methyl-chloride refrigerating plant with measuring equipment; a two-stage reciprocating compressor complete with dynamometer and other items; and a free-piston compressor. The heat-engine section of the laboratory can be seen in Fig. 5.

PLACES AVAILABLE AND AWARDS

If all these facilities are to be put to full and effective use then students of suitable calibre and in sufficient numbers must be found to fill the places available. Although the engineering school can accommodate about 60 students each year, only 32 were admitted last October, and 35 in 1954. This is particularly remarkable in view of the alleged overcrowding of English universities. In the recent intake only a third of the available places were filled by students from the United Kingdom—16 from Scotland, 4 from England; the remaining 12 students came from overseas.

As an encouragement to those considering an engineering education at Queen's College, a number of awards have been made by industrial concerns. Ferranti Limited, for example, award two cash prizes—known as "The Ferranti Prizes"—of £25, both available each year for award to the most distinguished student graduating with honours in applied physics (electrical) and electrical engineering. Another award has been made by the North of Scotland Hydro-Electric Board, who offer both the University of St. Andrews and the University of Aberdeen a scholarship in each year for a student—£200 if he is living at home and £250 otherwise—who is following a course for the degree of B.Sc. with honours in electrical engineering, and who is interested in electricity development in the north of Scotland.

For further information regarding entrance requirements and other details, application should be made to the Dean of the Faculty of Applied Science, Professor E. G. Cullwick.

The Starfighter supersonic fighter has a very thin straight wing and a "flying tail." It is powered by a General Electric J.79 turbojet of unspecified thrust.

UNITED STATES' FASTEST COMBAT AIRCRAFT

THE LOCKHEED F.104A STARFIGHTER

For the first time photographs and a few details of the F.104A Starfighter, stated to be the world's fastest combat aircraft and one which "packs more punch per pound than any jet fighter ever built," have been released by the manufacturers, the Lockheed Aircraft Corporation, Burbank, California, U.S.A. The supersonic Starfighter, which, they state, is a light-weight machine in all except striking power, is now in production and will shortly be delivered to tactical units of the United States Air Force. Early production models are undergoing exhaustive tests.

The top speed of the Starfighter has not been released; it is said to have a climbing speed equal to its speed in straight and level flight, and it is designed for operation in the upper stratosphere. The range is comparable to that of present-day fighter aircraft. The Starfighter is powered by the General Electric J.79 turbojet, which is claimed to have the highest thrust-to-weight ratio of any jet engine yet developed. In contrast to the sharply swept-back delta planforms that have generally been favoured for the present generation of supersonic aircraft, the Starfighter—designed for operation well into the supersonic régime—has a thin straight wing tapering to a square tip. It is claimed to be the thinnest wing that has yet flown. The choice of this configuration is the result of extensive study on various types of wing, including tests on 5 in. rockets travelling at several times the speed of sound, carried out in the desert.

Owing to the extremely thin wing, the undercarriage of the Starfighter retracts into the fuselage. It is the first production aircraft arranged for downward ejection of the pilot.

Other noteworthy features of the Starfighter are its "flying tail," mounted high on the swept-back fin, the entire surface of which is used for longitudinal control; and the downward pilot ejection system, said to be the first to be installed in a production jet fighter. This arrangement minimises the possibility of the pilot colliding with any part of the aircraft structure when baling out.

To eject himself the pilot has only to pull a handle to start an automatic chain of events: (*a*) the cockpit is depressurised and the control column moves forward out of the way; (*b*) the parachute shoulder harness snaps on to the pilot; his legs are pulled close to the body by "mechanical straps," and ankle-clamps hold the feet in place; (*c*) an explosive cartridge releases the escape hatch and jettisons the seat downward and outward; (*d*) the pilot's seat belt unsnaps, freeing him from his seat, and at a pre-set altitude the parachute opens.

The cockpit is placed well forward overlooking the Starfighter's sharp nose. In order to take advantage of the space within the fuselage for installation of equipment, the Starfighter's stubby wings do not extend through the fuselage as a single structural unit but are joined separately to the fuselage, nearly two-thirds of the distance back from the nose. The wings have 10 deg. of negative dihedral.

Two unusual structural features have resulted from the wing's extreme thinness ratio: (*a*) the main landing gear is designed to retract into the fuselage, (*b*) drop tanks at the wing tips fit over the wingtip like a glove, instead of being completely separate appendages. Provision has been made for under-wing pylon tanks if needed for extra fuel.

Flaps on the leading edge of the wing reduce the aircraft's landing speed and its take-off run. There are also trailing edge flaps and ailerons near the wing tip. Dive flaps, or brakes, are located behind the wing and about mid-way up the side of the fuselage.

A landing drag parachute similar to that introduced on Lockheed's F.940 Starfire jet interceptor, is installed on the lower part of the fuselage, near the end of the tailpipe.

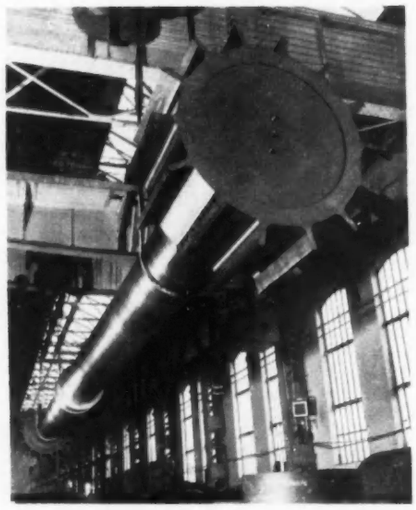
An example of the design simplicity applied to the Starfighter is a new "integrated electronics system" devised by Lockheed. By re-packaging the various communication and navigation components, they have been installed as a series of inter-connecting but self-sustaining units.

The separate units can be plugged quickly in place, or unplugged, to provide the aircraft with only the electronics equipment actually needed for a specific mission. Unnecessary weight is thus eliminated.

A large engine access door, on the bottom of the fuselage, serves a dual purpose. In addition to providing ready access to the engine, the door's inner panel holds most of the aircraft's hydraulic equipment, to facilitate servicing.

Another unique maintenance feature of the F.104A is attributable to its downward type seat ejection system. By removing the escape hatch underneath the cockpit, the entire seat installation can be slid down and out, thus providing stand-up working room for a mechanic.

Dimensions of the new aircraft are: height, 13 ft. 6 in., length, 54 ft. 9 in., span, wing-tip to wing-tip, 21 ft. 11 in.



A 57 ft. hollow transmission shaft, fitted with shrunk-on Holset patent coupling inner members, made at the River Don Works of English Steel Forge and Engineering Corporation Ltd., Sheffield.

FIFTY-SEVEN FOOT TRANSMISSION SHAFT

Runs True to 0·001 in.

A hollow transmission shaft weighing 42 tons and measuring 57 ft. 2½ in. in length and 28 in. in diameter, and intended for transmitting the drive from two 3,500 h.p. electric motors in tandem to the upper pinion of a 42 in. reversing slabbing rolling mill at the Shotton Works of John Summers & Sons, Limited, has now been completed at the River Don Works of English Steel Forge and Engineering Corporation, Limited, Sheffield, 9. The shaft, seen in the above illustration, has been made to the order of Davy and United Engineering Company, Limited, Sheffield, and, as will be seen, it is fitted with shrunk-on inner members of patent flexible couplings made for the Holset Engineering Company Limited, Huddersfield. The shaft, which has a bore of 20 in., and the two inner members, each 34½ in. wide, with outside diameters of 66½ in., were all machined from solid forgings. When the assembly was given its final inspection before dispatch to Shotton, where it is now in operation, the shaft was found to run true to one thousandth of an inch on its two outer bearings and centre bearing. Moreover, all fourteen blades of each Holset coupling member were found to be truly in line both to the axis of the shaft and to the corresponding blades on the opposite member.

The shrinking-on to the shaft of the various components called for meticulous care and high accuracy. Plugs 35 in. long had to be aligned exactly with the bore and manipulated into position while the expanded shaft end was unsupported. After machining the shaft, two 3 in. wide centre thrust collars, having an outside diameter of 36 in., had to be kept heated throughout the building operation in order to be set in position 25 ft. from the end of the shaft. Finally, the inner members themselves were expanded into position.

Much of the success of the whole operation is due to the availability of machine tools capable of dealing with work of this magnitude. The finish machining of the shaft was carried out on a 25 in. by 80 ft. long centre lathe, while, for the assembly, a 36 in. by 60 ft. long centre lathe was employed.

It may be of interest to note that the length of the shaft is due to the need for transmitting the drive from the motors to the rolling mill over a previously-existing steam engine which, at the time, it was intended to retain as a stand-by power unit.

NOTICES OF MEETINGS

British Institution of Radio Engineers

LONDON
"Radio and Television Interference: Its Growth and Effects," by M. Smith. London Section. London School of Hygiene and Tropical Medicine, Keppel-street, W.C.1. Wed., April 25, 6.30 p.m.*

British Productivity Council

LONDON
Films and Discussion on Productivity Problems. Organised by the North London Productivity Committee. National College of Rubber Technology, Northern Polytechnic, Holloway-road, N.7. Thurs., May 3, 2.30 p.m. (Tickets 2s. 6d.)

Building Centre

LONDON
Films: "Plumbers' Brassfoundry." Wed., April 25, 12.45 p.m.

Chadwick Public Lecture

LONDON
"Centenary of London's Main Drainage System," by J. Rawlinson. Royal Society of Health, 90 Buckingham Palace-road, S.W.1. Thurs., April 26, 5.30 p.m.

Chemical Society

BRISTOL
"Magnetism and the Shape of Inorganic Molecules," by Professor R. S. Nyholm. Bristol Branch. Chemistry Department, The University, Bristol. Thurs., April 26, 5.15 p.m.
EXETER
"Surface Diffusion," by Professor R. M. Barrer. Exeter Branch. Washington Singer Laboratories, Exeter. Thurs., May 3, 5 p.m.

Illuminating Engineering Society

BIRMINGHAM
"Blackpool Illuminations," by H. Carpenter. Birmingham Centre. Regent House, St. Phillip's-place, Colmore-row, Birmingham. Fri., April 27, 6 p.m.
NOTTINGHAM
"Outdoor Illuminations," by H. Carpenter. Nottingham Centre. Offices of the East Midlands Electricity Board, Smithy-row, Nottingham. Thurs., April 26, 6 p.m.

Incorporated Plant Engineers

BIRMINGHAM
"Atomic Energy," by Dr. J. H. Fremlin. Birmingham Branch. Imperial Hotel, Birmingham. Fri., April 27, 7.30 p.m.
CARDIFF
Discussion on "Cost and Planning of Maintenance," organised by the British Productivity Council. South Wales Branch. South Wales Institute of Engineers, Park-place, Cardiff. Tues., April 24, 7.15 p.m.
LEEDS
Film: "Volga Don Canal." West and East Yorkshire Branch. The University, Leeds. Mon., April 30, 7.30 p.m.
SHEFFIELD
"Bearings and Bearing Failures," by A. Holligan. Sheffield Branch. Grand Hotel, Sheffield. Thurs., April 26, 7.30 p.m.

Institute of British Foundrymen

LONDON
Annual General Meeting. "Casting of a Large Winding-Drum Cheek," by A. W. Bartlett. London Branch. Waldorf Hotel, Aldwych, W.C.2. Wed., April 25, 7 p.m.
BIRMINGHAM
Annual General Meeting. Birmingham Branch. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., April 25, 7.15 p.m.
BRISTOL
Annual General Meeting. Bristol and West of England Branch. Grand Hotel, Bristol. Sat., April 28, 3 p.m.
COVENTRY
Annual General Meeting and Film Evening. Coventry Section. Technical College, Coventry. Tues., April 24, 7.30 p.m.
LETCHWORTH
Annual General Meeting. Bedfordshire and Hertfordshire Section. At works of K. and L. Steelfounders and Engineers Ltd., Letchworth. Thurs., April 26, 7.30 p.m.

Institute of Fuel

NOTTINGHAM
Annual General Meeting and Film Evening. East Midland Section. Gas Board's Showrooms, Nottingham. Thurs., April 26, 6.15 p.m.

Institute of Industrial Supervisors

CHELTENHAM
Film Evening: "More About Modern Materials—Detergents, Fibre Glass, Tipped Tools and Terylene." North Gloucestershire Section. Town Hall Annexe, Cheltenham. Thurs., April 26, 7.30 p.m.
HARROW
"Airing Your Own Problems: The Foreman's Part in Work Study," by A. J. Speakman. London North West Section. Harrow Technical College, Harrow. Thurs., April 26, 7.30 p.m.

Institute of Marine Engineers

LONDON
"Fundamental Principles of Marine Instrumentation," by F. P. Rout. Mon., April 23, 6.30 p.m.*
Annual General Meeting. Tues., April 24, 5.30 p.m.*
LIVERPOOL
"The Carriage of Edible Oil and Similar Bulk Cargoes," by John Wormald. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Mon., April 23, 6.30 p.m.*

Institute of Metals

LONDON
"The Beginnings of Metallography," by Professor Cyril S. Smith. Wed., April 25, 6.45 p.m.

Institute of Petroleum

ROCHESTER
"Oil Tanker Operations," by Captain A. Nesbitt. South Eastern Branch. King's Head Hotel, Rochester. Tues., May 1, 7.45 p.m.

Institute of Physics

LONDON
Symposium on "Principles of Penetrant Methods." Papers will be read on the problems encountered in the use of penetrant methods of industrial inspection, by H. L. Carson, W. G. Cook and Dr. R. Schnurmann; and on the physics of the problems and the research needed for their solution, by Sir Eric Rideal, Dr. E. W. J. Mardles, A. de Waele and Dr. K. Weissenberg. Non-Destructive Testing Group. Fri., May 4, 6.30 p.m. (Admission by ticket.)

Institute of Refrigeration

LONDON
"Use of Radioactive Techniques in Refrigeration Engineering," by D. B. Smith. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., May 3, 5.30 p.m.* (Alteration of date.)

Institution of British Agricultural Engineers

LONDON
"Hydrostatic Transmission for Tractors," by H. J. Hamblin. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Tues., April 24, 6 p.m.*

Institution of Chemical Engineers

LONDON
Annual General Meeting. Business Session, for corporate members only, at 11 a.m. Presidential Address on "The Technological Awakening," by John A. Oriel, at 12 noon. Annual Dinner at 7 for 7.30 p.m. May Fair Hotel, Berkeley-street, W.1. Tues., April 24.

Institution of Civil Engineers

LONDON
"The Investigations, Design and Construction of Paya Lebar Airport, Singapore," by J. J. Bryan. Airport Division. Tues., April 24, 5.30 p.m.*
Informal Discussion on "Mechanised and Mobile Gang Maintenance of Track," to be opened by J. R. Hammond, H. H. Robinson and I. G. White. Thurs., April 26, 5.30 p.m.*
Graham Clark Lecture on "The Impact of Engineering on Society," by Sir Maurice Bowra. Joint Meeting with the Institutions of Mechanical and Electrical Engineers, at the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Fri., April 27, 5.30 p.m.*
"Pumping Problems, Present and Future," by Herbert Addision. Joint Meeting with the Institution of Mechanical Engineers. Tues., May 1, 5.30 p.m.*
NOTTINGHAM
Films: "The Kittimat Story" and "Little Aden Oil Harbour." Midlands Association. Mechanics Institute, Trinity-square, Nottingham. Tues., May 1, 6.15 p.m.*
SHEFFIELD
Annual General Meeting. Yorkshire Association. Royal Victoria Hotel, Sheffield. Fri., April 27, 6.15 p.m.

Institution of Electrical Engineers

LONDON
Informal Evening on "Electronics and Automation." "Automatic Assembly Systems for Electronic Equipment," by G. W. A. Dummer. Together with films and demonstrations. Radio and Telecommunication Section. Mon., April 23, 5.30 p.m.*
"Physical Properties and Impulse Strength of Paper," by

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. (MUSeum 1901.)
British Productivity Council. Apply to Mr. Charles Cooper, 126 The Ridgeway, Enfield. (HOWard 2611.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chadwick Trust, 90 Buckingham Palace-road, London, S.W.1. (SLOane 5134.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham. (Solihull 3021.)
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. (Blackfriars 6178.)
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1. (LANgham 7124.)
Institute of Industrial Supervisors, 24 Albert-street, Birmingham 4. (Midland 6971.)
Institute of Marine Engineers, 85 The Minories, London, E.C.3. (ROYal 8493.)
Institute of Metals, 4 Grosvenor-gardens, London, S.W.1. (SLOane 6233.)
Institute of Petroleum, Maason House, 26 Portland-place, London, W.1. (LANgham 2250.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (SLOane 9806.)
Institute of Refrigeration, Dalmeny House, Monument-street, London, E.C.3. (MINcing Lane 6851.)
Institution of British Agricultural Engineers, 6 Buckingham-gate, London, S.W.1.
Institution of Chemical Engineers, 56 Victoria-street, London, S.W.1. (VICtoria 6161.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1. (SLOane 7128.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
Physical Society, 1 Lowther-gardens, South Kensington, London, S.W.7. (KENsington 0048.)
Royal Aeronautical Society, 4 Hamilton-place, London, W.1. (GROsvenor 3515.)
Royal Institution, 21 Albemarle-street, London, W.1. (HYDe Park 0669.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2. (TRAfalgar 2366.)
Royal Statistical Society, 21 Bentinck-street, London, W.1. (WELbeck 7638.)
Sheffield Society of Engineers and Metallurgists, University of Sheffield, St. George's-square, Sheffield 1. (Sheffield 24071.)

H. C. H[illegible] and E. Kelk; "The Impulse Strength of Lapped Impregnated-Paper Dielectric," by H. C. Hall and D. J. Skipper; and "Breakdown under Impulse Voltages of Solid and Liquid Dielectrics in Combination," by W. G. Standring and R. G. Hughes. Joint Meeting of Supply and Measurement Sections. Wed., April 25, 5.30 p.m.*
Kelvin Lecture on "Radio Astronomy," by Professor A. C. B. Lovell. Thurs., April 26, 5.30 p.m.*

GLASGOW
Annual General Meeting. "The Recent Search for and Salvage of the Comet Aircraft near Elba," by Commander C. G. Forsberg, R.N., and G. G. MacNeice. South West Scotland Sub-centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Wed., May 2, 7 p.m.

MANCHESTER
Annual General Meeting. North Western Centre. Engineers' Club, Albert-square, Manchester. Tues., May 1, 6.15 p.m.

Institution of Heating and Ventilating Engineers

GLASGOW
Annual General Meeting and Discussion on "Heating of Large Chambers." Scottish Branch. Scottish Building Centre, 425 Sauchiehall-street, Glasgow, C.2. Tues., April 24, 7 p.m.

LIVERPOOL
Annual General Meeting. Liverpool Branch. College of Building, Clarence-street, Liverpool. Wed., April 25, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
Discussion on "Are Diesel Engines Inherently Noisy?" Internal Combustion Engine Group. Tues., April 24, 6.45 p.m.*
"Precision Engineering," by W. C. Mongar. London Graduates' Section. Wed., April 25, 6.30 p.m.*
Graham Clark Lecture on "The Impact of Engineering on Society," by Sir Maurice Bowra. Joint Meeting with the Institutions of Civil and Electrical Engineers. Fri., April 27, 5.30 p.m.*
"Pumping Problems, Present and Future," by Herbert Addison. Joint Meeting with the Institution of Civil Engineers, at the Institution of Civil Engineers, Great George-street, S.W.1. Tues., May 1, 5.30 p.m.*

BRISTOL
"Ball and Roller Bearing Development," by M. J. Knaggs. Western A.D. Centre. Royal Hotel, Bristol. Thurs., April 26, 6.45 p.m.

Institution of Production Engineers

LONDON
"The Finishing of Work by Polishing and Plating," by H. Cann. London Graduate Section. Tues., April 24, 7.15 p.m.

MANCHESTER
"The Factory Acts and How They Affect Engineering Establishments," by Sir George Barnett. North Western Regional Meeting. Manchester College of Technology, Sackville-street, Manchester. Mon., April 23, 6.30 p.m.

WOLVERHAMPTON
"Work Study and the Production Engineer," by J. V. Connolly. Wolverhampton Section. Wolverhampton and Staffordshire Technical College, Wulfruna-street, Wolverhampton. Wed., April 25, 7.15 p.m.

Institution of Structural Engineers

LONDON
"Design and Construction of the Printing Works at Debden," by Sir Howard Robertson, Ove Arup, R. S. Jenkins and H. F. Rosevear. Thurs., April 26, 6 p.m.

Junior Institution of Engineers

BIRMINGHAM
"Electronic Control: The New Power in Industry," by John A. Sargrove; and film "The First Automatic," showing a wireless receiver made entirely by machines. Midland Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., May 2, 7 p.m.

MANCHESTER
Repetition of Presidential Address on "Dams," by G. M. Binnie. North Western Section. Engineers' Club, Albert-square, Manchester. Tues., April 24, 7.30 p.m.

SHEFFIELD
Repetition of Presidential Address on "Dams," by G. M. Binnie. Sheffield Section. Royal Victoria Hotel, Sheffield. Mon., April 23, 7.30 p.m.

Physical Society

LONDON
"Use of Radioactive Techniques in Refrigeration Engineering," by D. B. Smith. Low Temperature Group. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Thurs., May 3, 5.30 p.m.* (Alteration of date.)

Royal Aeronautical Society

LONDON
"The Development of Helicopter Transport: Experiences Obtained in British European Airways Experimental Flying and Operations," by R. H. Whitby. Tues., April 24, 7 p.m.

Royal Institution

LONDON
"Edmond Halley and His Work," by Sir Harold Spencer Jones. Fri., April 27, 9 p.m.

Royal Meteorological Society

LONDON
Annual General Meeting. Presidential Address on "The Moisture Balance of the Atmosphere," by Dr. R. C. Sutcliffe. Wed., April 25, 5 p.m.* (Alteration of date.)

Royal Society

LONDON
"Spin Fluctuation Scattering of Neutrons and the Ferro-Magnetic State in Iron," by R. D. Lowde; and "The Brueckner Theory of Nuclear Structure," by R. J. Eden. Thurs., May 3, 4.30 p.m.*

Royal Society of Arts

LONDON
"Modern Welding," by Dr. H. G. Taylor. Second Lecture. Mon., April 23, 6 p.m.
"Beauty in Danger: The Rural Scene," by Sir George Pepler. Wed., April 25, 2.30 p.m.
"The Snowy Mountains Scheme," by C. M. Gray. Thurs., April 26, 5.15 p.m.*

Royal Statistical Society

GLASGOW
Annual General Meeting, at 7.15 p.m. Film on "Techniques for Tomorrow" at 8 p.m. Glasgow Industrial Applications Group. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. Thurs., April 26.

SHEFFIELD
"Figures for the Manager," by Stafford Beer. Sheffield Industrial Applications Group. Grand Hotel, Sheffield. Thurs., April 26, 6.30 p.m.

Sheffield Society of Engineers and Metallurgists

SHEFFIELD
Film evening. Mon., April 23, 7.30 p.m.

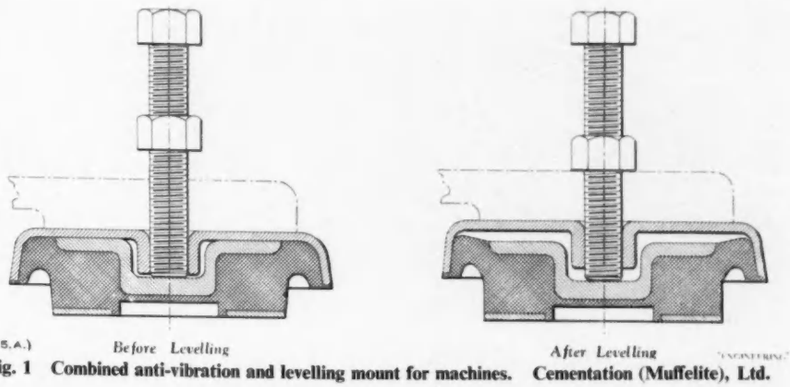


Fig. 1 Combined anti-vibration and levelling mount for machines. Cementation (Muffelite), Ltd.

TOWARDS IMPROVED PRODUCTION

MANY USEFUL AIDS DISPLAYED AT THE FACTORY EQUIPMENT EXHIBITION

The fourth Factory Equipment Exhibition was held at Earl's Court, London, from April 9 to 14. It was opened by the President of the Board of Trade, the Rt. Hon. G. E. P. Thorneycroft, P.C., M.P., and was sponsored by *The Factory Manager* and the *Factory Equipment News*. This year the exhibition was larger than ever and over 250 firms took part. Mr. Thorneycroft congratulated the organisers on this growth and drew attention to the ways in which equipment can make for a smooth flow of work. This year, for the first time, there were exhibitors from abroad. During the exhibition, conferences were arranged on work study by the British Productivity Council and it was hoped that informal, lively and constructive criticisms would encourage the activity of British industries.

Also speaking at the opening ceremony, Mr. G. M. Vignoles, managing director of Shell-Mex and B.P., Limited, appealed to the Government to assist the oil-burner manufacturers to produce the special equipment needed in time to make possible the great extension of the industry called for by the growth of the industrial use of oil fuel. He drew attention in particular to the display mounted by his own company, which brought together the products of 70 manufacturers of oil-burning equipment.

The exhibition covers all those items which go to make up what might be called the auxiliary equipment required by the factory. Such items as cleansing creams, hand washing equipment, including hot air driers and paper towels as well as automatic linen driers, were well to the fore, and factory heating equipment took up a very large area. As regards administration and the inevitable paper work required for the efficient running of a factory, there were intercommunication systems, dictation and duplicating machines as well as small printing presses for the dissemination of news, instructions and labels. Progress charting was well represented and eight firms were showing different types. One interesting point that was well brought out by the number of different exhibitors was the growth of the use of the "slotted angle" type of construction, both for permanent and temporary work; no less than 10 separate firms were showing this type of construction and it was also used, without advertisement, in many of the displays on other stands.

Office furniture had its place and showed to what extent the welfare of staff was now being considered with a view to obtaining greater efficiency by reducing fatigue. Every factory has to meet the problem of storage, and the fact that 26 firms were exhibiting different forms of shelfs, racks and cupboards showed that the need is appreciated in industry.

As in previous years, protective clothing formed quite a large part of the exhibits and included asbestos suits and nylon overalls. Another use of nylon shown for the first time at this exhibition was the development of a tarpaulin made of nylon fibre and proofed with P.V.C.; this gives a very light material weighing approximately 14 oz. per square yard as against the oil-proofed flax tarpaulin which weighs about 32 oz. per square yard. It has a very high tensile strength and a high flex strength; being immune to attack from bacteria and free

Fig. 2 Sonatron sensitive miniature stethoscope, with large sound magnification. Airsonic, Ltd.

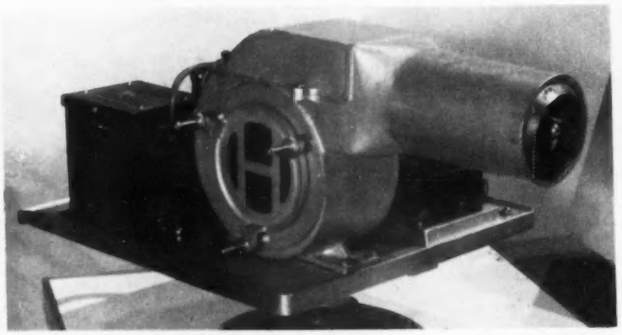


Fig. 3 Automatic oil burner for central heating boilers, rated between 200,000 and 400,000 B.Th.U. per hour. Hope's Heating and Engineering, Ltd.

from the danger of rot, it is suitable for long use under arduous conditions. It should retain its ease of handling throughout the whole life.

Of all the intercommunication systems shown the most elaborate was probably that on the General Electric Company's stand, where a central control desk, working in conjunction with a main panel, operated a staff call intercommunicating telephone, alarm systems, time signals and a " Music while you work " system run from a tape recorder. In addition, high-frequency frequency-modulated or amplitude-modulated radio broadcasts could also be played over the system. Another exhibit was the automatic announcing system which is now being used at Stratford Station to announce incoming trains. It uses a wide tape on which 25 different announcements can be recorded and selected by means of push buttons. The tape is in the form of a continuous loop which stops automatically after one complete revolution.

On show for the first time was the new G.E.C. flameproof loudspeaker specially designed for use in inflammable atmospheres such as may be encountered in the oil or paint industries. Another new addition on the stand was air-conditioning equipment; this means that another firm is now entering this rapidly extending field. At the exhibition 10 other firms were showing equipment for this purpose.

LEVELLING SHOCK ABSORBERS

In order to render machines more mobile and at the same time to reduce vibration, Cementation (Muffelite), Limited, were showing the Barrymount levelling device. This consists of a rubber block mounted between two plates, on the upper of which the foot of the machine rests, while the block itself stands on the floor. An adjustable screw passes through the upper plate and is used to raise or lower the machine foot until it is level. The diagram, Fig. 1, shows the construction. Vibrations and shocks are absorbed by the rubber block, and the range of mounts available has load ratings from 70 to 2,500 lb. Even the largest size only raises the machine by about 2½ in. above floor level.

For detecting sources of vibration and thereby locating faults, Airsonic, Limited, were displaying the Sonatron, which is a sub-miniature instrument, easily portable and with a gain of up to 90 decibels. The equipment, in its box, is shown in Fig. 2. In use it is similar to the industrial stethoscope that the firm have been making for some time, but is much smaller and more sensitive. The new model is tunable between 25 and 20,000 cycles per second and, using a long probe, a leak in a 10 in. diameter water pipe, 3 ft. 6 in. underground, was first detected 250 yards from the point of the leak. By moving the probe in the direction of increased noise the actual position of the leak was determined. Supplied with the unit are the industrial probe, which incorporates a crystal contact microphone, and an electrical probe which indicates the presence of live wires at a distance of several feet. In addition, small portable loudspeakers can also be supplied; the instrument works from two miniature batteries and, complete in its case, weighs only 18 oz.

A device, by no means new, but which is worth a reminder, is the " Sani-Snake," designed for cleaning clogged pipes, exhibited by Charles C. Grey. It consists, very simply, of a length of flexible coiled wire with a helix attachment at the end for cutting blockage and a small feeding device which can be held or clamped at the entrance to the pipe. The length of wire is rotated by a unit very similar to a standard hand drill and screws its way through the feeding head into the pipe. Its extreme flexibility allows it to progress round almost any bend and it will clear ordinary accumulations of sludge. Sizes are made suitable for pipes up to 6 in. in diameter.

An essential part of factory work is the labelling of the final product and several firms were exhibiting printed adhesive tapes for this purpose, as well as automatic machines for sticking printed labels on to tins or bottles. Adams Powel Equipment, Limited, were exhibiting machines for the semi-automatic glueing of cartons and also for closing them by riveting; in addition, they showed a large range of stapling machines. For printing labels and similar work, among the firms present were Dapag (1943), Limited, who were showing examples of their range of " Tickopress " machines. In one model the type is held in slots on the printing drum and can be slid on to a " stick " for transfer to and from the type case. These machines have automatic numbering which can be made consecutive or in batches up to 16 of the same number, and can print at the rate of 150 a minute. Several other models are available for different types of work.

A feature of present-day exhibitions, which was exemplified in this one, is the grouping together of equipment of the same type, forming, as it were, a specialised exhibition within the exhibition general. Two examples were present: one of control equipment and the other of oil-burning equipment (already referred to) mounted by Shell-Mex. The products of 70 manufacturers were ranged on the stand, so that visitors had a chance of comparing different types and selecting the one most suitable for their requirements.

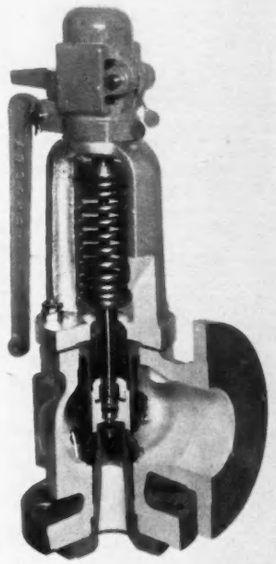
Fairly typical of the smaller units was the one shown in Fig. 3, made by Hope's Heating and Engineering, Limited, which is for central heating boilers with ratings from 200,000 to 400,000 B.Th.U. per hour. It is fully automatic in operation; other sizes are available. More than 150 exhibits were displayed on the stand, ranging from plant for heating factories of 1,500 sq. ft. and upwards, to equipment for boilers generating up to 50,000 lb. of steam per hour. The packaged boiler was represented by several examples from different makers. Radiant space heating was in operation between the two parts of the stand, the fuel used being Bottogas.

Unique among the " gadgets " on exhibition was the " Jet " pattern developer made under licence by Triangle Products, Limited. It is designed for laying out sheet, metal work to give the form required for elbows, joints and junctions of various sorts. When the device has been set up all that is necessary is to chalk the edges of the patterns and then roll the assembly over the sheet metal, when the pattern traced out will be the required form for cutting.

SAFETY VALVES WITH HIGH DISCHARGE

The H.S. range of safety valves made by the Crosby Valve and Engineering Company, Limited, Ealing-road, Wembley, Middlesex, have a high discharge capacity and have been given a coefficient of 30 (the maximum) by Lloyds Register of Shipping. This coefficient is C in the formula $W = C.A.P.$, where W is the weight of steam discharged in pounds per hour, A is the nozzle area and P the lifting pressure of the valve.

The illustration shows the construction of these valves. The pressure joint between the safety valve and the boiler is made on the nozzle flange, so that only the stainless steel nozzle and disc are normally subjected to the steam pressure. The nozzle fits loosely to the body so that undue any distortion due to non-uniform expansion of the body is avoided. Adjusting rings are provided on both nozzle and guide, enabling low blowdown to be attained in addition to positive opening and closing, and both have flat seats which can easily be resurfaced if necessary.



The internal construction of the H.S. range of safety valves incorporates flat seats on both disc and nozzle, and allows high discharge rates.

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WELDING CONFERENCE

London, June 1957

Organised by the Institute of Welding, the first British Commonwealth Welding Conference will be held in London and at Saltburn-by-Sea, Yorkshire, from June 17 to 29, 1957. The main objects of the conference are to exchange information on the present technical position of the welding processes and their main applications within the Commonwealth; to consider means of improving the exchange of technical information about welding; and to emphasise the importance of the contribution which welding can make increasingly to the development of modern engineering production.

Ten sessions, each of three hours, will be allotted to the papers, and offers of papers for presentation at the conference are invited. These offers should be made on a form obtainable from the secretary and must be received at the conference office by August 1, 1956. The secretary of the conference is Mr. G. Parsloe, M.A., and all communications should be addressed to the secretary, Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1.

In Parliament

ATOMIC ENERGY FOR INDUSTRY

Among the matters of technical interest to come before Parliament since sittings of the two Houses were resumed on April 10, on the termination of the Easter recess, was the problem of how to control the use of atomic energy by industry. Mr. W. N. Warbey (Labour) pressed the Lord Privy Seal for information respecting the progress of research by the United Kingdom Atomic Energy Authority into the non-military use of energy derived from the fusion of light elements, and was told by Mr. R. A. Butler that the investigation of the possibilities of obtaining economic power from controlled thermonuclear reactions was part of the Authority's research programme. Mr. Butler said he was satisfied that that was the only way in which progress could be made and he added that, until more experience of this particularly intricate problem had been gained, he could not give any further particulars. He appreciated the need for care in passing on details about fusion processes, but pointed out that a good deal of information had been published already at Geneva and elsewhere.

No statutory limitations had at present been imposed on the number, type or capacity of the nuclear reactors that might be constructed, owned or operated in the United Kingdom by private industry, but it should be emphasised that any control necessary in this connection could be exercised through the Authority's monopoly of fissile material. The Government had in reserve certain powers under the Atomic Energy Acts, but they considered that they needed the assistance of private industry and did not feel that any abuse had arisen.

Mr. Butler agreed with Mr. G. Nabarro (Conservative) that one of the objects of these Acts was to obtain the maximum possible co-operation between the privately-owned electrical and mechanical-engineering industries.

68 HOUR WEEK AT DOUNREAY

Sir David Robertson (Conservative) drew Mr. Butler's attention to the 68 hour week being worked at the construction of the Authority's power station at Dounreay, pointing out that manpower for other essential building work on housing, schools, and for agricultural purposes could not be obtained unless excessive overtime earnings on a similar scale were paid. Sir David asked if the Authority could be directed to operate two 8 hour shifts a day at Dounreay in future.

In reply, Mr. Butler said he had been informed by the Authority that the single-shift system in operation at Dounreay was necessary to complete the work in time for the station to fulfil its function in the nuclear power programme. Recruitment of two 8 hour shifts, if it were possible, would mean an increase of at least 40 per cent. in the labour force employed, amounting to 800 more men at the peak period. In the Authority's opinion, that would cause more local disturbance than the present arrangements. These latter arrangements were probably the best way in which progress could be made in a singularly difficult problem. Asked by Mr. Geoffrey Wilson (Conservative) for an assurance that no steps would be taken to delay the Dounreay project, which was vital to this country's future, Mr. Butler said that that was one reason why those rather exceptional hours were being worked. As to getting the work well done, there were the usual remissions which occurred when such long periods had to be worked.

SAFETY RULES FOR CIVIL AIRWAYS

The Minister of Transport and Civil Aviation was asked by Mr. Phelim O'Neill (Ulster Unionist) what rules military and other aircraft had to observe when flying in the vicinity of civil-aircraft corridors in the United Kingdom. Mr. Harold Watkinson replied that for aircraft flying under visual flight rules there were no special restrictions applying to their flight in the vicinity of airways. Under instrument flight rules, all civil aircraft had to obtain permission from air-traffic control before crossing an airway. Military aircraft, other than fighters, normally did the same, and, if they could not do so, they were required to cross at predetermined heights, different from those being used by aircraft flying on the airway. Fighter aircraft usually crossed airways under radar control but, in exceptional circumstances, they could use the procedures applicable to other military aircraft.

The Minister agreed that it was very important, in view of greatly increased congestion on the airways, that these rules should be strictly observed, especially near large aerodromes. To Mr. Ernest Davies (Labour), who wondered whether the existing rules were sufficient to meet present-day requirements, Mr. Watkinson said that that matter would be reviewed when the report of an inquiry into a recent incident was received. He promised to look into a suggestion put forward by Lieut.-Colonel A. J. McKibbin (Ulster Unionist) that British aircraft should be fitted with forward radar to enable them to detour bad-weather zones, as was the case with the latest American and Swiss machines.

Mr. J. Rankin (Labour) pointed out that military and civil aircraft usually flew under separate controls, especially near London Airport, and asked whether it would be possible for these controls to be synchronised, on safety grounds. Mr. Watkinson described this as a good suggestion and promised to inquire into it.

Make-up of British Merchant Fleet

A number of questions in relation to the post-war progress of British shipping were put to Mr. Watkinson. He informed Mr. T. George Thomas (Labour), who represents Cardiff West, that in September, 1939, approximately 57 per cent. of the gross tonnage of the United Kingdom merchant fleet consisted of liners and about 18 per cent. of tankers. The corresponding percentages in January, 1956, were 51 per cent. and 28 per cent., respectively. There were no vessels specially constructed to carry ore in the United Kingdom fleet in 1939. Ten vessels of this nature were included in the fleet in January last, but their total tonnage was less than half of 1 per cent. of the total fleet. In another answer to Mr. Thomas, the Minister said that information regarding the proportion of the world's seaborne trade carried by British tramp steamers in 1939 and 1955, respectively, was not available.

Ballast Sailings to North America

Also in reply to Mr. Thomas, who inquired whether there had been any increase during the past two months in the numbers of merchant vessels leaving this country in ballast for the purpose of seeking cargoes in North American ports, Mr. Watkinson said that there did not appear to be anything exceptional in these movements. Some 201 merchant vessels of all flags left the United Kingdom in ballast during January and February, 1956, bound for North American ports, compared with 205 vessels during the corresponding two months of last year. So far as he could judge from the figures available, there had not been any considerable increase in this trade during recent years.

Motor-Vehicle Testing Stations

Sir Frank Medlicott (National Liberal and Unionist) asked whether the attention of the Ministry of Transport and Civil Aviation had been drawn to the findings of Hendon vehicle-testing station that the tyres, brakes, headlights and steering arrangements of 97 per cent of cars registered before 1945 were in need of adjustment or repair. Sir Frank said that the corresponding figure for cars registered between 1945 and 1953 was 85 per cent., and, even for cars registered since 1953, no less than 66 per cent.

Mr. Watkinson replied that he agreed that the figures quoted showed the real need, on safety grounds, for the testing service. He had no plans, however, for opening further testing stations in advance of any general scheme of vehicle testing which might be instituted if Parliament gave its assent to the proposals which he had tabled for inclusion in the Road Traffic Bill. He agreed with Sir Frank that anyone who had studied the Hendon figures must conclude that a testing service was needed. In answer to Mr. Ernest Davies (Labour) who referred to the need for speeding up the passage of the Bill, Mr. Watkinson said he hoped it would become law before long.

Decline in B.I.F. Exhibitors

In answer to questions by Mr. A. G. Bottomley (Labour) about the closure of the London section of the British Industries Fair, Mr. A. R. W. Low, Minister of State to the Board of Trade, agreed that there had been no consultation with the Exhibitions Advisory Committee before that decision was taken, but added that there had been full consultation with the directors of British Industries Fair Limited, whose chairman was a member of the committee. A large amount of money was involved, the Board of Trade were well aware of the views of industry and an early decision was important. In these circumstances, consultation with the committee had not been thought necessary.

Exhibitors at the Fair's London section numbered 2,153 in 1947, increased to 2,309 in 1948, and declined steadily each year since then, to a total of 1,010 in 1954, and 600 in 1955. Of the number of firms exhibiting in 1954, no fewer than 318 took only display windows and not complete stands. Figures supplied by the Birmingham Chamber of Commerce, who were responsible for the Birmingham section, showed that there were 1,012 exhibitors at that section in 1947, and that the number remained in the eleven hundreds during the next six years. In 1954, there were 986 exhibitors, and 979 in 1955.

Colonial Problems for British Scientists

Mr. J. R. Bevins, Parliamentary Secretary to the Ministry of Works, who represents the Lord President of the Council in the House of Commons, was asked by Mr. Ian Mikardo (Labour) what steps were being taken to implement the proposals of the Advisory Council on Scientific Policy regarding home-based pools of scientists for use in connection with colonial problems. Mr. Mikardo was informed that pools of scientists for use in this way had been established at the instance of the Secretary of State for the Colonies at a number of agricultural research institutions and also at certain stations of the Department of Scientific and Industrial Research. A new pool had been set up for stored products research and two other pools had been enlarged.

Diesel-Electric Trawlers

Mr. Hector Hughes (Labour) pointed out that the research ship, M.S. Sir William Hardy, built at Aberdeen, was the first British trawler to be electrically propelled and inquired what steps were being taken to apply this technique to other fishing trawlers. Mr. S. W. Digby, Civil Lord of the Admiralty, replied that, although the use of that method of propulsion was a matter for the trawler owners themselves, the technical assistance of the Admiralty was always available to the shipbuilding and marine engineering industries, should they require it. There were, in fact, other orders in hand in British shipyards for Diesel-electric trawlers.

Underground Gasification of Coal

Mr. Austen Albu (Labour) asked for the overall capital cost per megawatt of work and plant installed for the generation of electricity by the underground gasification of coal, and for the cost per unit of power so generated. He was informed by Mr. Aubrey Jones, Minister of Fuel and Power, that the only estimates of cost that could be made at this stage were based on small-scale experimental systems, of which the largest produced gas sufficient to generate 300 kW continuously for some months. While these estimates encouraged the hope that underground gasification could be exploited economically, they were based on a number of assumptions, the validity of which it had not yet been possible to test.

THE HUMAN ELEMENT

A marginal change in unemployment figures—The rate for the job on farms—Motor-car workers want a Government inquiry into their industry—Three-day strike due to a misunderstanding—The housewife's point of view on short-time working—Company chairman is the oldest union member.

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The Employment Situation

Between the middle of February and the middle of March, the number of unemployed decreased by 10,000 and at the latter date were 4,000 fewer than at the same time a year ago. In March the percentage of unemployed was 1·2 compared with 1·3 in February and in March, 1955. The latest figures for numbers working overtime in manufacturing industry are for the week ending February 25. At that date there were reported to be 65,000 operatives on short-time losing on the average 11½ hours each. On the other hand, there were 1,560,000 production workers averaging 8 hours overtime each.

Thus, judged by the latest figures, there was no drastic change in the situation in the labour market up to the middle of March. It is not possible for even the gloomiest pessimists to see disaster for workers as a whole when the unemployment percentage falls by 0·1 per cent. It is important to keep this sense of proportion in mind. There is no doubt that there will have to be a drop in overtime and some temporary unemployment in some industries if inflation is to be halted. It is wrong, however, to read into the dislocation of one or two industries a country-wide worsening of the employment situation. On the whole, men are still scarce.

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Agricultural Wages Policy

Recent statements by officials of the National Union of Agricultural Workers suggest that the demands for increases in wages will be pressed most strenuously this year. There is widespread dissatisfaction with the turning down of their last claim. Last week the general secretary of the union, Mr. Harold Collinson, warned that "we are getting to that point where we are getting really annoyed." The annual conference of the Warwickshire branches of the union approved a resolution urging that farm-workers and farmers should co-operate more closely and should insist upon the adoption of a long-term plan for the production and marketing of all agricultural produce. This need for long-term planning was stressed in the Lords debate on the Government's farm price policy. In the words of Lord Walpole: "Why should farmers bear the continued anxiety of wondering what is going to happen at the next price review?"

The concern for long-term planning will also be in evidence when the N.U.A.W. hold their bi-annual conference next month. A sub-committee of the union have prepared a scheme, which has been approved by the Executive, for the introduction of a new wages structure. The National Farmers' Union are in favour of a wages structure which would give incentives to skilled workers. The nature of the work on farms has altered radically in the past decade, owing to the rapid and widespread introduction of machinery. The sub-committee recommmend that differentials should be based on the grading of the job and not on the employer's assessment of his workers.

The union's plans should make for a considerable tidying up of the industry's wages and thus make easier the farmer's task of calculating his return on investment in machinery. The rate for the job, however, when so many jobs are done by the same worker, could create problems of demarcation besides which those arising in shipbuilding would be child's play. The union are to be congratulated on their attempt to introduce logical rates of pay, but they must not under-rate the difficulties of "a rate for the job." It is the small, not the large farmer, who will find it difficult to apply the new rates without raising his already disproportionately high costs.

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Cars and Their Makers

Some 400,000 engineering workers in this country get their livelihood directly—and many more indirectly—from the manufacture of motor vehicles, and a very good livelihood it is. Average wages since the war have been substantially higher than in any other industry. Nowhere have such large numbers of semi-skilled and un-skilled workers—who predominate—been paid so much. Now they are worried, and have lost no time in translating their worries into a demand for action. They want an immediate fact-finding inquiry into the general position of their industry, "including design, capital investment, profit, export organisation, restrictions and distribution costs." A resolution was passed last week by the executive council of the Confederation of Shipbuilding and Engineering Unions that the Government should be asked to instigate an immediate inquiry.

For the first time since the war the industry has experienced a seasonal fall in demand, accentuated by the imposition of restrictions on hire purchase and of an increase in purchase tax. The unions are opposed to any restrictions on home sales. But in spite of the restrictions it was a seasonal fall in demand accompanied by short-time and lay-offs, which is traditional in the industry throughout the Western world. There will be one next year and every year until the spring ceases to have its special meaning. To be competitively strong the industry must put itself into a position to meet peak demand, and this means under-employment or—in sterner times—unemployment during the off season. This is particularly so if the Australasian markets, whose summer corresponds to our winter, fail to regain their importance for the British industry.

The workers request an inquiry; we suggest that this will yield little that is not already known. The industry is a "growth" industry and will continue to grow for some years, but not of course without growing pains and not without painful wastage in some factories. All the workers ask for are facts about their own industry and these should be freely available. In fact they can be obtained. Why then are the workers in the dark? This surely is a weakness which could easily be remedied by the industry itself.

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Divided Loyalties

The temper of engineering labour has become noticeably shorter in recent months. The disputes at the Rolls-Royce Scottish factories, at Cammell Laird's Birkenhead shipyard, and many others not so widely publicised, suggest that the will to see the other side's point of view is diminishing. Mr. Macleod, Minister of Labour, told the Institute of Public Relations last week that 1955 was the worst for strikes in 20 years; this year is unlikely to be any better. The amount of time lost through strikes is not high—it averaged between two and three hours per man last year—and compares favourably with most other industrialised nations, but it is the nature of the disputes which is disturbing. Too many suggest poor communications between labour and management.

Last week 1,100 members of the Amalgamated Engineers Union stopped work for three days at the Diesel engine works of Mirrlees, Bickerton and Day in Stockport, because the works convener was suspended for that period by the company's managing director for refusing to obey the summons of the works manager while attending a meeting of the shop stewards' committee. The committee are reported to have told the convener that his loyalty was to them and that he should not [illegible] the meeting. In their discussion with the [illegible]agement the union officials argued that [illegible]onvenor was "torn between two loyalties, [illegible]o which the managing director replied: "[illegible]e must make up his own mind whom he wo[illegible] for—after all we pay the wages."

That such situations should [illegible]ise at all is a sorry, and costly, business for industry.

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The Female of the Species

The National Conference of Labour Women held its annual meeting in London last week. Among the items was a spirited debate on the economic situation and the cost of living. Being a gathering of women—and politically conscious women at that—the picturesque was not discarded for the factual when it came to giving abuse. As might be expected from such a gathering, the present Government was the main target for obliquy although there were times when the opposite sex in general came in for a certain amount of unfavourable comment.

There is one point which comes out of the deliberations of such a gathering (no matter what may be its political complection) which is exceedingly relevant to industrial relations. It is this. Most women on such occasions take the point of view of the housewife. They see the cost of living from an important angle. They see it as the wage packet measured against the quality as well as the quantity of goods, against the quality of service. They have a unique angle on the shorter working week. They see the strike in terms of unfed mouths and of men in the way rather than in terms of principle. Their influence is therefore immense, though on the whole unorganised.

Yet does management pause to consider what their influence may be on a particular industrial dispute with labour? In isolated communities like the coal mining areas, to mention an extreme case, feminine opinion can be quickly mobilised; elsewhere it is potent but diffuse. It has power and coherence (of a sort). Its resources as a constructive element in industrial relations have hardly yet been tapped.

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Master and Man

Last month Mr. W. W. Hackett, Snr., completed 60 years of trade union membership. It all began in 1896 when he was taken on as a turner at the age of 21 in a Birmingham engineering works. On the day he became a foreman the manager invited him to leave the union but Mr. Hackett stayed on. In due course he became one of the founders of the precision tube makers Accles and Pollock, Limited, and in course of time he became its chairman. Thus at 81 he is presumably the oldest paid-up member of the A.E.U. and chairman of a large company.

It is a situation to baffle the theorists and committee men alike. Is he the arch-type of repentant capitalist and unrepentant trade unionist all at the same time—or vice versa? Has he ever been in the difficult intellectual or moral position where he has had to strike against himself? Or worse, has he ever been in the physically awkward position of being on the inside and having to lock himself out? There must have been times, especially in the early days, when he was caught between two fires.

It is all very untidy and illogical by some people's standards. Yet it has worked for Mr. Hackett. He must have been a very tolerant man at times over those 60 years, though for all we know he may have been a tartar in the works. He must have had to learn to suffer fools, especially humourless and tidy-minded fools, gladly. It has certainly been a triumph of compromise and above all a triumph for the individual. If ever industry's role of honour is drawn up, when they have put up the great captains of industry and the great fighters for the rights of the working man, they must also find a place for Mr. Hackett—preferably in the middle between the other two.

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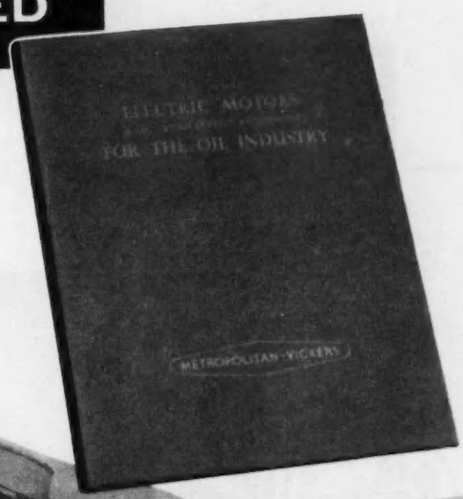

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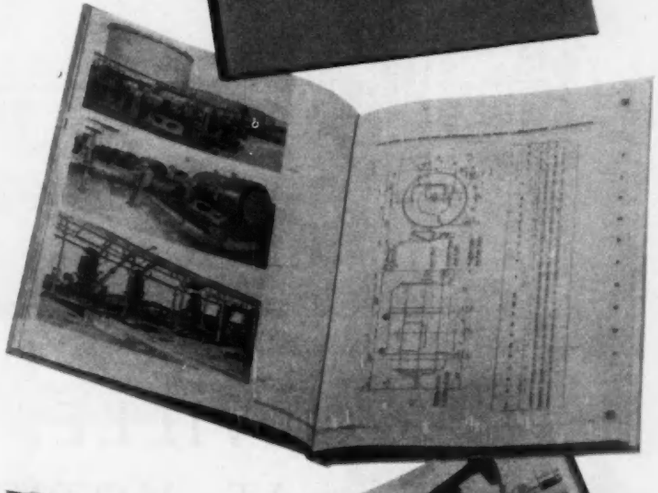

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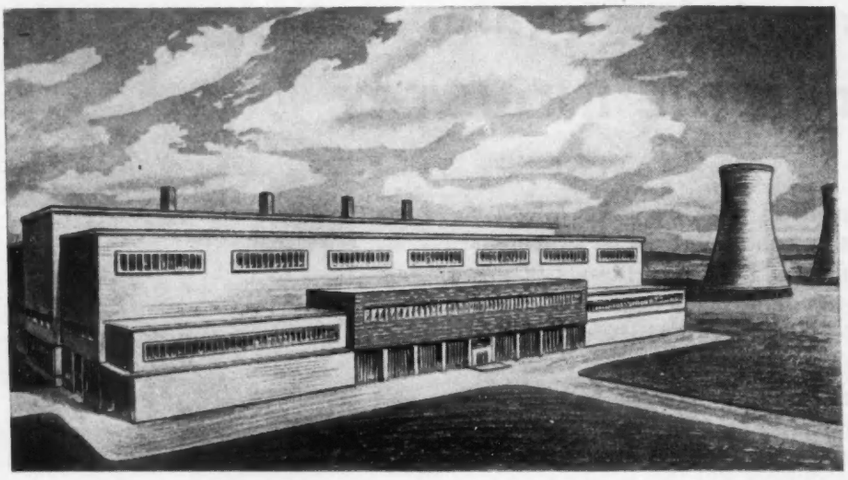

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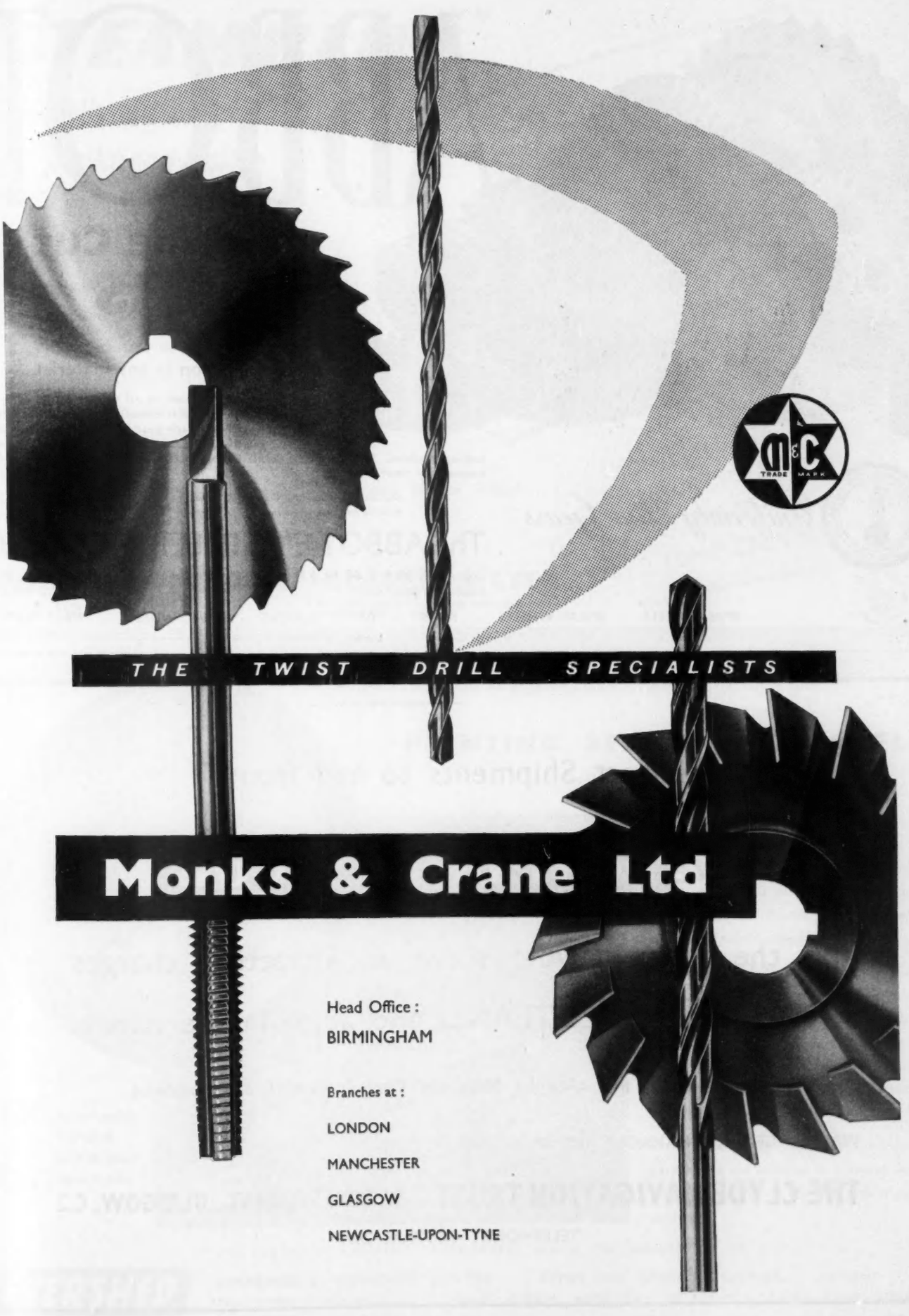
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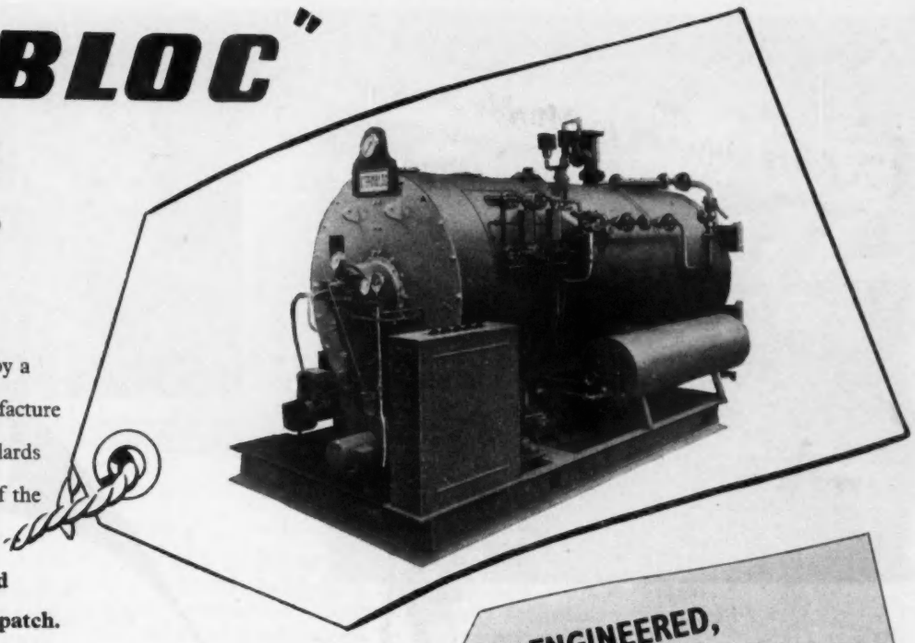

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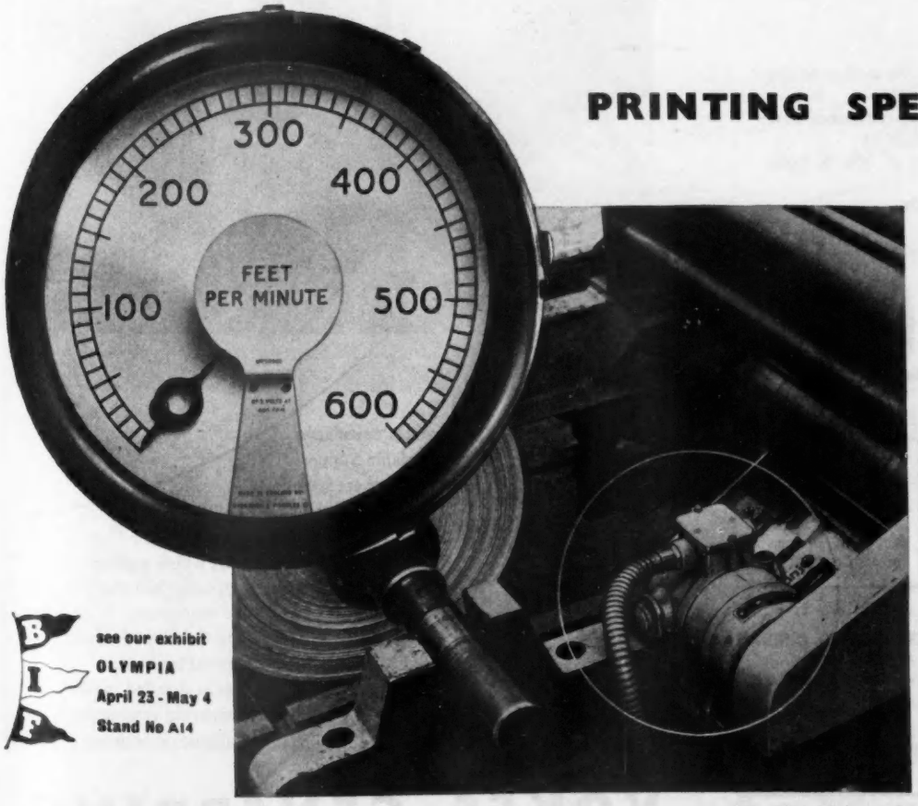

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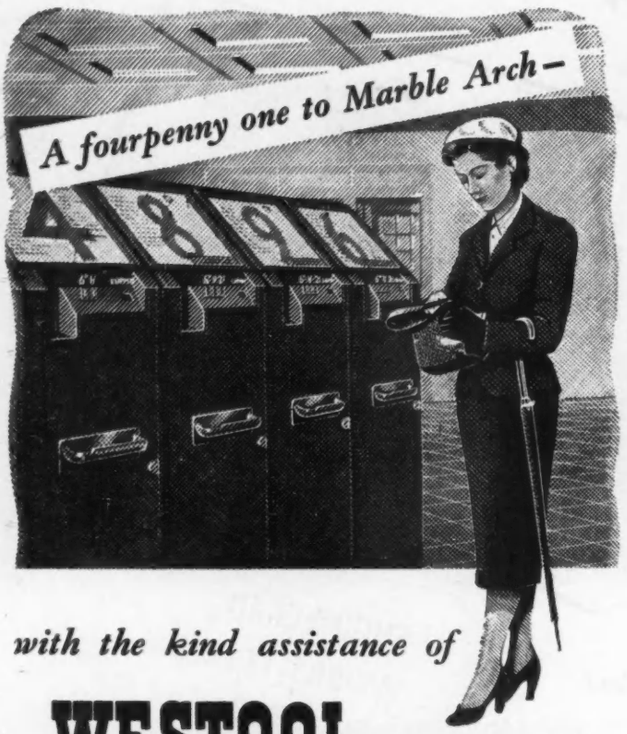
TELEPHONE: CHISWICK 3670 . CABLES: MEGGER, LONDON . TELEGRAMS: MEGGER, CHISK, LONDON

6/201



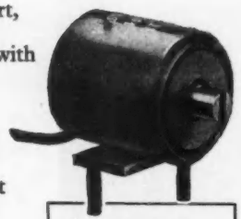
with the kind assistance of

WESTOOL Solenoids

THE money goes in—the ticket comes out! The traveller pays no thought to the magic that brought the ticket so quickly and easily to hand. But we suggest it would be worth *your* while to do so.

Westool Solenoids which help control the action of the London Transport Executive ticket issuing machines may be the means of increasing the efficiency of one of your processes. They can be employed to push, pull, open, shut, start, stop—in short, they are "the muscles of industry" with limitless applications.

Look around your works. See if you think there is a job of work that might be controlled by solenoids *—then get in touch with Westool for advice.*



A Series 2046 D.C. Solenoid used in L.T.E. ticket machines manufactured by Messrs. Brecknell, Dolman & Rogers Ltd. of Bristol

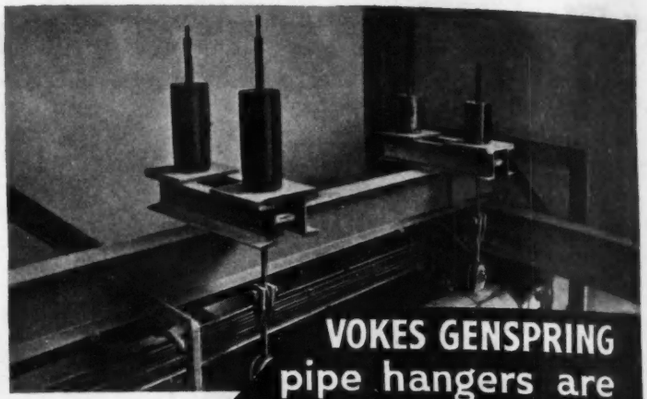
WESTOOL LIMITED

ST. HELEN'S AUCKLAND, CO. DURHAM
Telephone: West Auckland 317 (4 lines)
Cables: Solenoid, West Auckland

Export enquiries to Export Managers:
Stamm & Partners Ltd., 59 St. Martin's Lane, London, W.C.2
Telephone: Temple Bar 5383 (10 lines) *Cables:* Stamstam, London

Westool also make Coils, Coil Winding Machines, Transformers, Warner Electric Brakes and Clutches, Grinders, Small Motors, Vibrators, Air Conditioners etc.

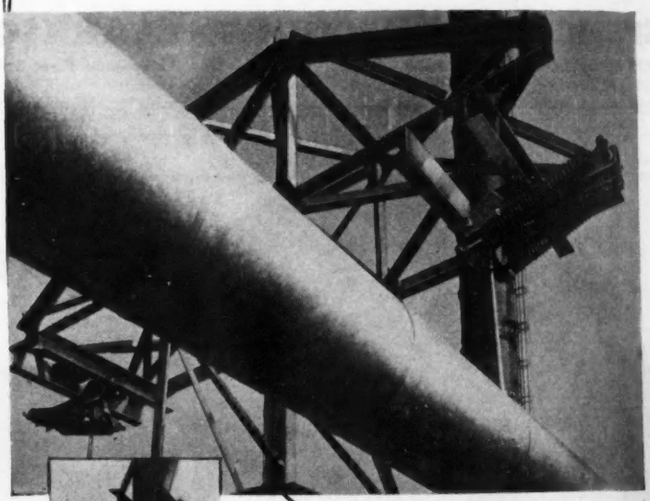
Tib. 18



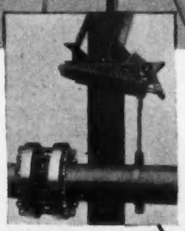
Photograph by courtesy of The Associated Ethyl Company Limited.

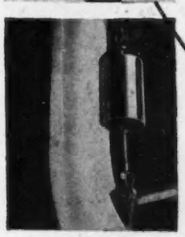
VOKES GENSPRING pipe hangers are used throughout the oil industry

At their Ellesmere Port Works in Cheshire, The Associated Ethyl Company Limited have made use of VOKES GENSPRING Variable Support Pipe Hangers to control movement which could set up very great stresses in the piping. 'Shell' have also incorporated VOKES GENSPRING hangers throughout the Platforming Unit at their Stanlow Refinery in Cheshire.



Photograph by courtesy of 'Shell'.





VOKES GENSPRING Variable Support Hangers are specifically designed for the control of vibration and limited thermal movement of piping, but where piping systems need to be 'floated' to offset the effects of extensive movement, Vokes Genspring Constant Support Hangers should be used. The full range is detailed in the Vokes Genspring catalogues available on request.

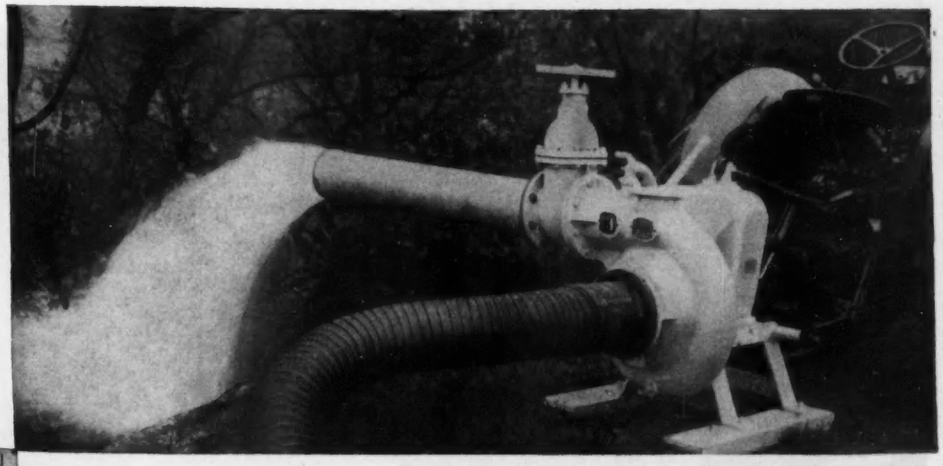
VOKES GENSPRING

SUSPENSION SYSTEMS

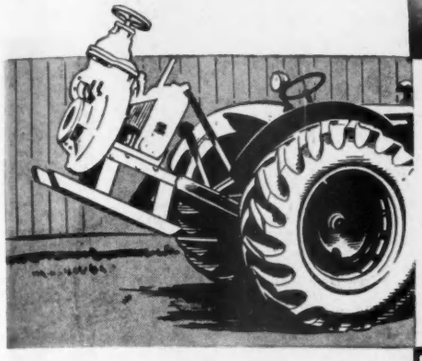
DEPT. 1/2 · VOKES GENSPRING LIMITED · GUILDFORD · SURREY

VG/11

The readily transportable irrigation pump that delivers 2,000 gallons a minute



A Gilkes 8-inch "D" Type Pump shown mounted on an International Harvester Super BWD 6 diesel tractor.



The GILKES 8-inch "D" Type Irrigation Pump embodies many special features. Mounted on an agricultural tractor in a few minutes, it is simple to operate, and is strongly built to withstand the toughest treatment. This handy, easily maintained pump can flood an acre of water 1 in. deep, **in twelve minutes!**

Approved by leading tractor makers. For specifications and performance details, write for leaflet GGG 29.

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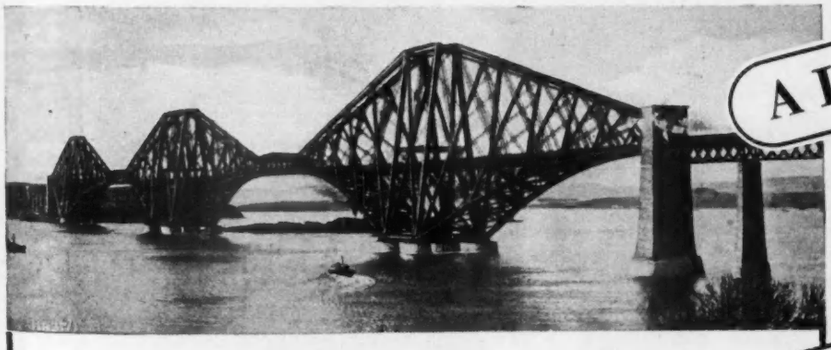

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and a guarantee of finish and dependability in steel castings, either black or machined. Over 40 years' experience in producing high grade castings up to 25 cwts.
Ample facilities for accurate machining are available if required.

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GILLY *HIGH SPEED* HORIZONTAL BORING & FACING MACHINE

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- *WIDE RANGE OF HIGH SPEEDS AND FEEDS*
- *CONVENIENT CONTROL*

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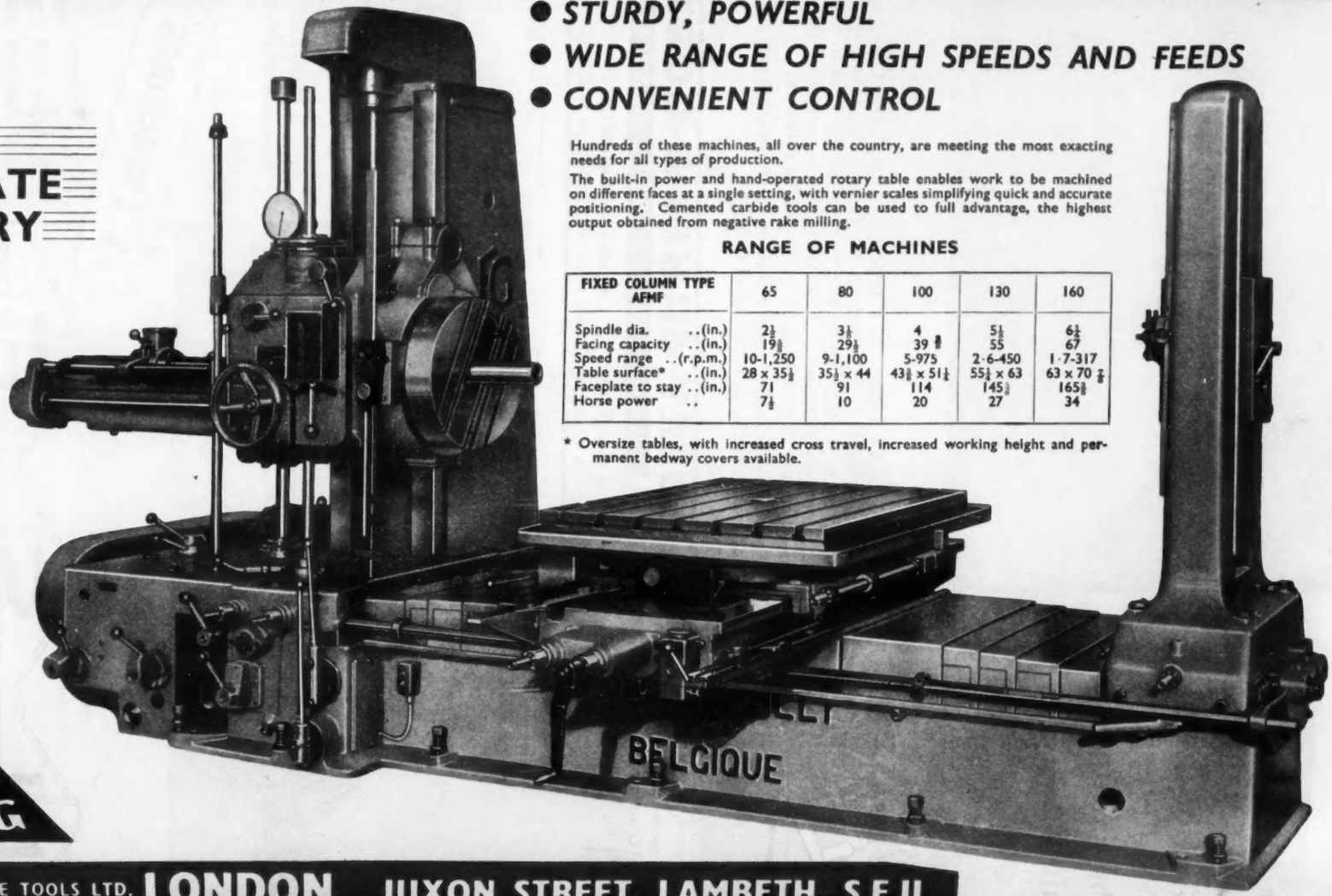

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Spindle dia. ..(in.)	2½	3½	4	5½	6½
Facing capacity ..(in.)	19⅝	29½	39 ⅜	55	67
Speed range ..(r.p.m.)	10-1,250	9-1,100	5-975	2·6-450	1·7-317
Table surface* ..(in.)	28 x 35½	35½ x 44	43½ x 51½	55½ x 63	63 x 70 ⅞
Faceplate to stay ..(in.)	71	91	114	145½	165⅝
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* Oversize tables, with increased cross travel, increased working height and permanent bedway covers available.

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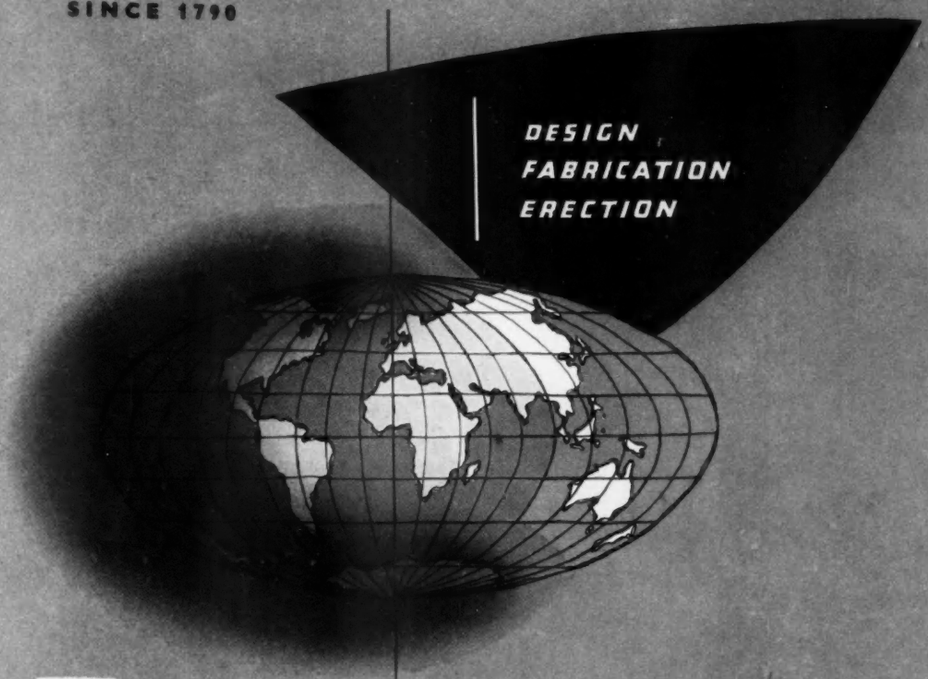

Constructional Steelwork

Examples of Butterley structural steelwork are to be found in all parts of this country and in many countries overseas. In recent years, experiments to perfect methods of welded structure have been highly successful.

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Railway and road bridges built by Butterley have been supplied to undertakings in Great Britain and many countries abroad. The Butterley Company was one of the pioneers of the "rolling-in" method now universally adopted. To-day, welded methods are widely used, but many bridges are still of riveted construction.

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LONDON OFFICE: 9 UPPER BELGRAVE STREET, LONDON, S.W.1

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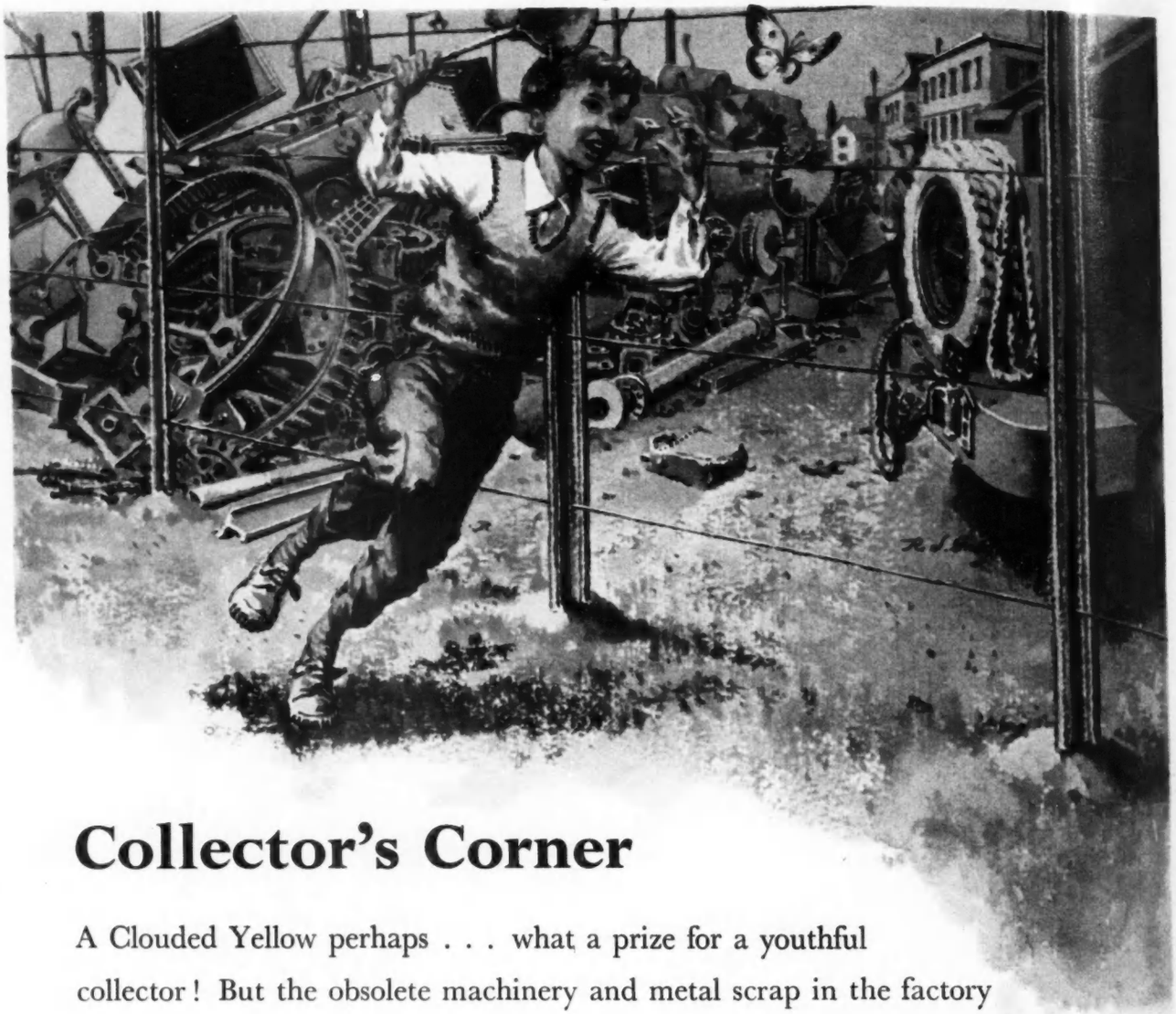

Collector's Corner

A Clouded Yellow perhaps . . . what a prize for a youthful collector! But the obsolete machinery and metal scrap in the factory yard is a collector's item, too — for an organization like Thos. W. Ward Ltd. who have the facilities to handle it on a large scale.

Scrap metal accounts for more than half the metallic charge fed into Britain's iron and steel furnaces. Much of this passes through Wards' depots where mountains of metal are sorted and processed every day.
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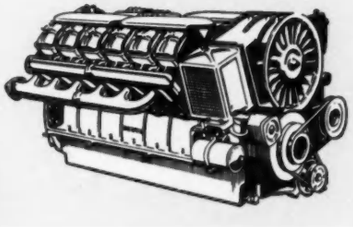

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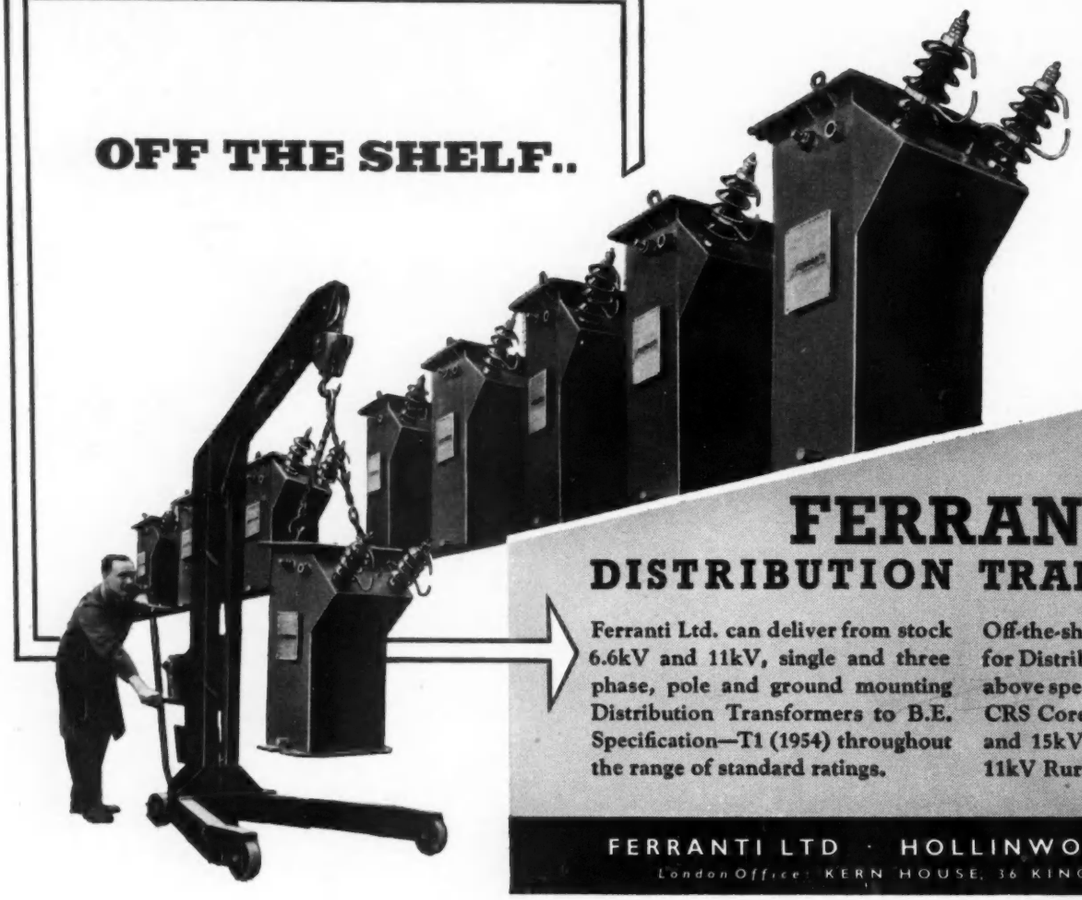
OFF THE SHELF..



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DISTRIBUTION TRANSFORMERS

Ferranti Ltd. can deliver from stock 6.6kV and 11kV, single and three phase, pole and ground mounting Distribution Transformers to B.E. Specification—T1 (1954) throughout the range of standard ratings.

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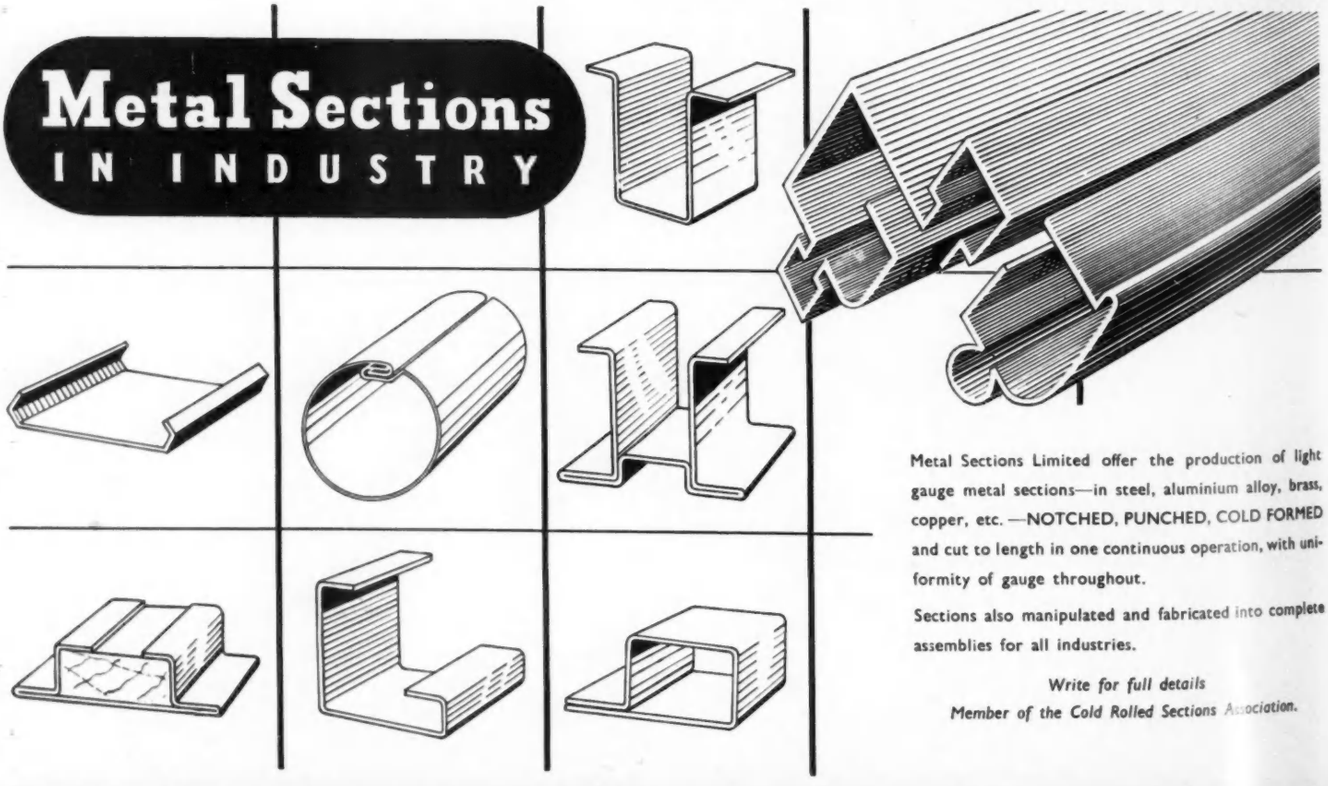

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Sections also manipulated and fabricated into complete assemblies for all industries.

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Member of the Cold Rolled Sections Association.

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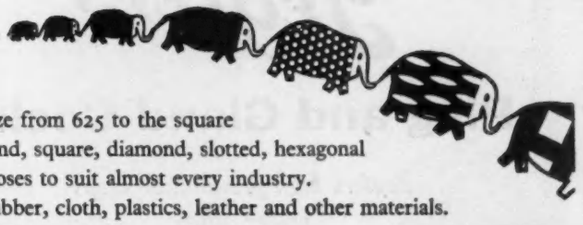
A [illegible] COMPANY

Perforated metals

in hundreds of different designs . . . .



These are produced by Braby from standard dies. Round holes vary in size from 625 to the square inch to a diameter of 3 in. Steel and non-ferrous metals with round, square, diamond, slotted, hexagonal and oval perforations are manufactured by Braby for an immense variety of purposes to suit almost every industry.

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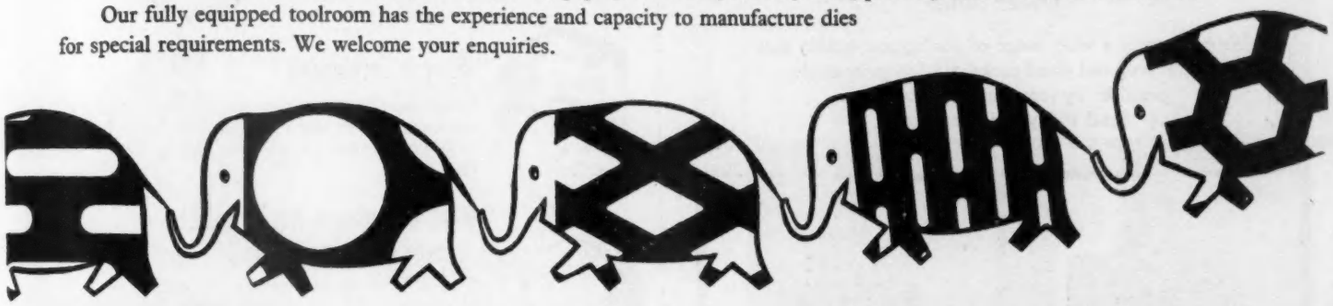
Our fully equipped toolroom has the experience and capacity to manufacture dies for special requirements. We welcome your enquiries.



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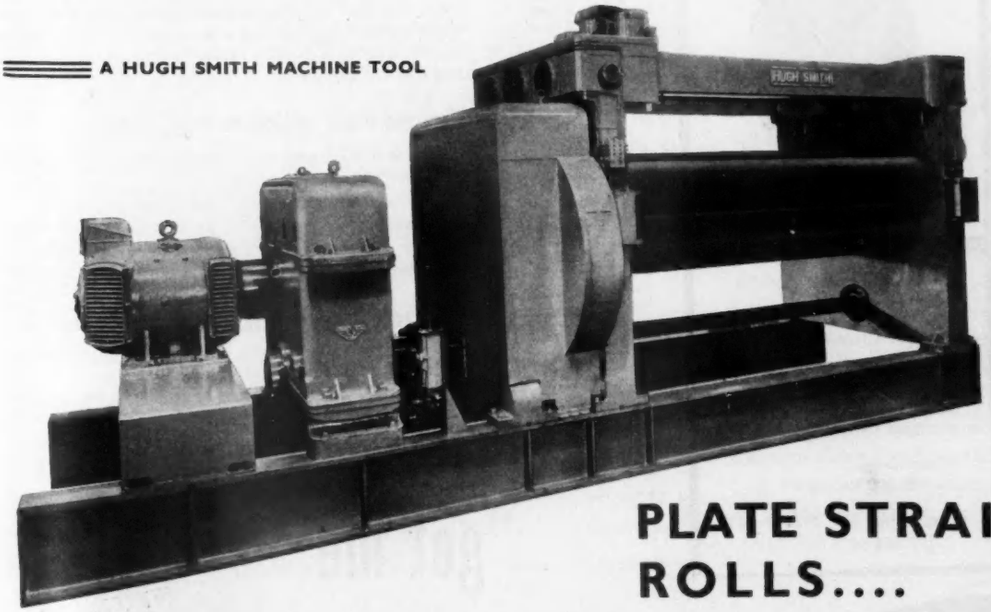

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PLATE
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of modern robust construction suitable for shipyards and structural shops where the continuous production of flat plates is essential.

The machines are of the seven-roller type having four rollers above and three below. The top rollers are hand-elevated on the smaller models, and motorised on the larger sizes. The two central top rollers are raised and lowered simultaneously to suit the plate thickness and the two outside rollers have independent motors for raising and lowering as required. A range of sizes is made to handle plates up to 10ft. wide and up to $1\frac{1}{16}$in. thick.

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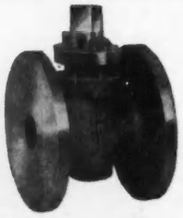
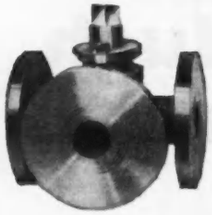
1081 Gunmetal plug cock. Female ends tapped BSPT (Taper) (BS21). For steam pressures up to 150 lbs. p.s.i. ¼"—3". 1082 for pressures up to 200 lbs. p.s.i. ¼"—2".

1111 Gunmetal threeway gland cock. ("T" or "L" Port). Female ends tapped BSPT (Taper) (BS21). For pressures up to 150 lbs. p.s.i. ¼"—2".

1090 Gunmetal gland cock. Female ends tapped BSPT (Taper) (BS21). For pressures up to 150 lbs. p.s.i. ¼"—3". 1091 for pressures up to 200 lbs. p.s.i. ¼"—2".



1093 Gunmetal flanged gland cock. Flanged to BST "E". For Steam pressures up to 100 lbs. p.s.i. 1"—3".



1097 Gunmetal threeway flanged gland cock. ("T" or "L" Port) Flanged to BST "E". For pressures up to 100 lbs. p.s.i. 1"—3".

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Pet and Drain Cocks ⅛"—½".

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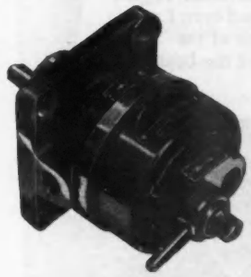

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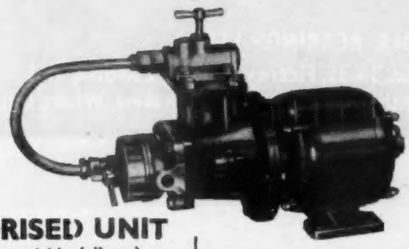

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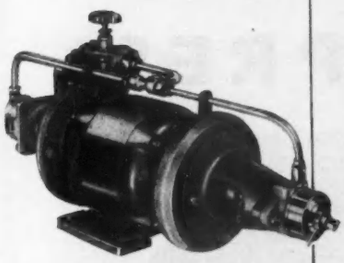

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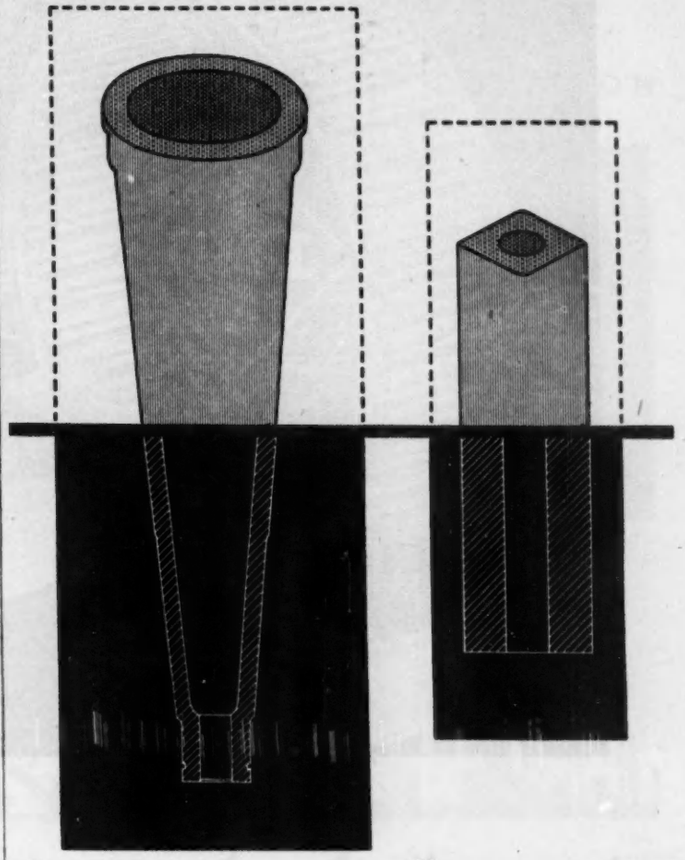

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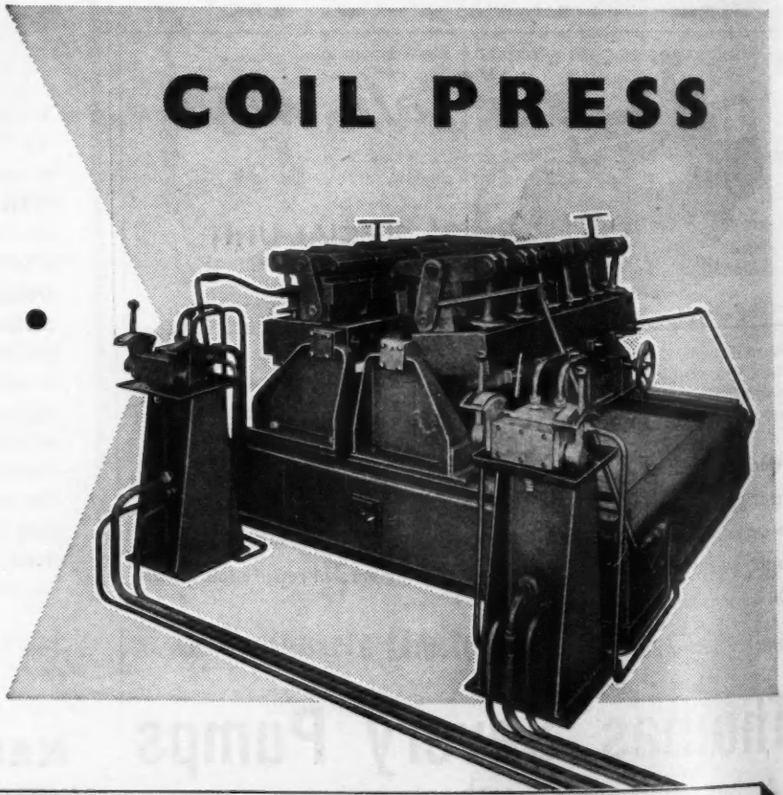

The machine illustrated is typical of the special purpose presses which L.E.H. develop and manufacture to customers requirements.

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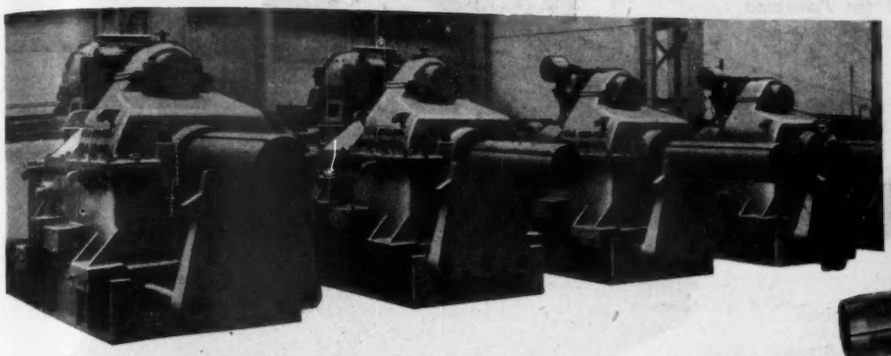

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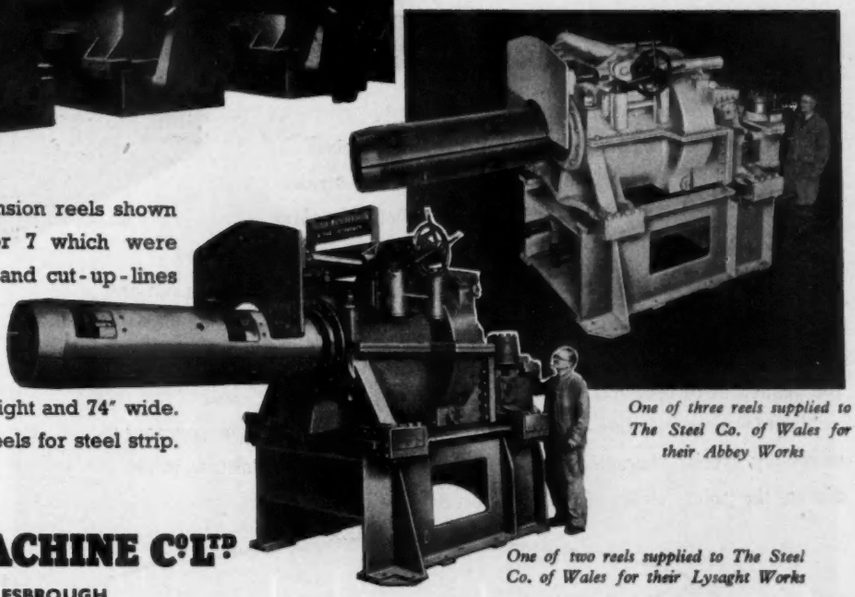
HEAD WRIGHTSON



The four Head Wrightson pay-off and tension reels shown above represent part of an order for 7 which were supplied for temper mill, slitting line, and cut-up-lines handling aluminium strip. Designs are available for many sizes and types of pay-off and tension reels. Units now being built are suitable for coils of 20 tons weight and 74" wide. One customer has recently ordered 9 reels for steel strip.

One of three reels supplied to The Steel Co. of Wales for their Abbey Works

One of two reels supplied to The Steel Co. of Wales for their Lysaght Works

If you require cold strip mill equipment consult

THE HEAD WRIGHTSON MACHINE Co. LTD.

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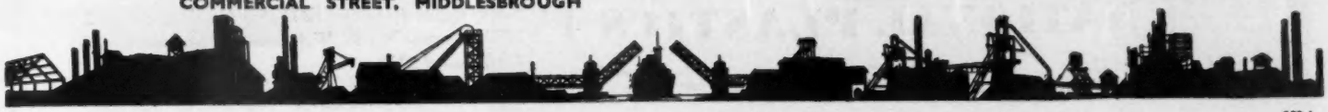
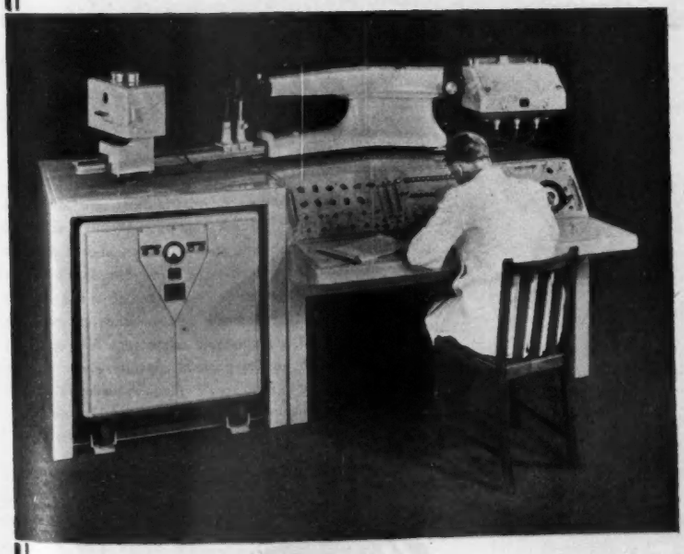


302-L

Direct-reading spectrochemical analysis



Please write for catalogues CH 383 (E.N.4), CH 392 (E.N.4) and CH 398 (E.N.4).

Up to ten elements can be quickly and accurately analysed with the Direct-Reading Attachment to the Hilger Medium Quartz Spectrograph. The plateholder is replaced by a unit accommodating eleven slits and photomultipliers and the slits can be adjusted accurately on any desired set of spectral lines. The time taken for measurement is about five seconds per channel. Sensitivity is high and reproducibility is often better than that obtained with photographic methods. This electronic console is available in two forms; as a desk to support the spectrograph and house the source unit (as illustrated) or as a box to stand on a bench.

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NP.33

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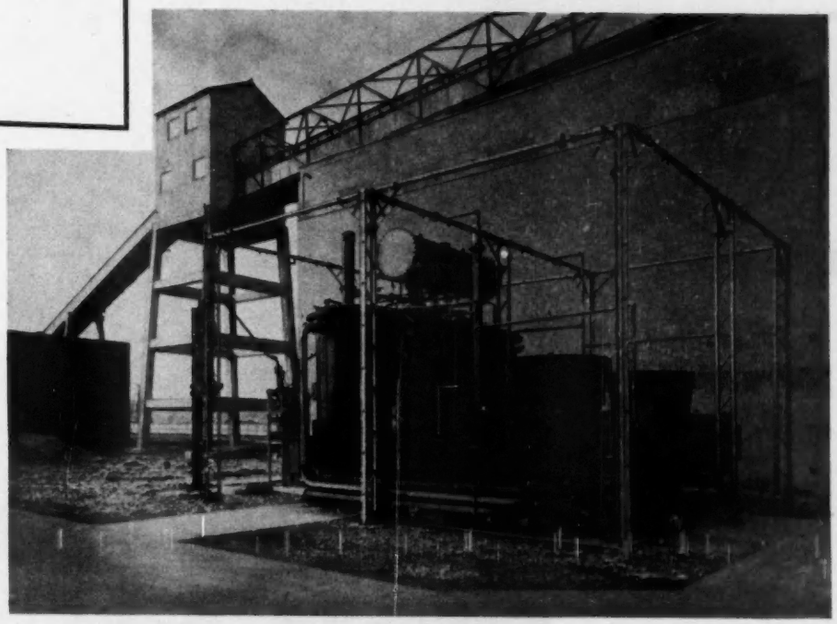
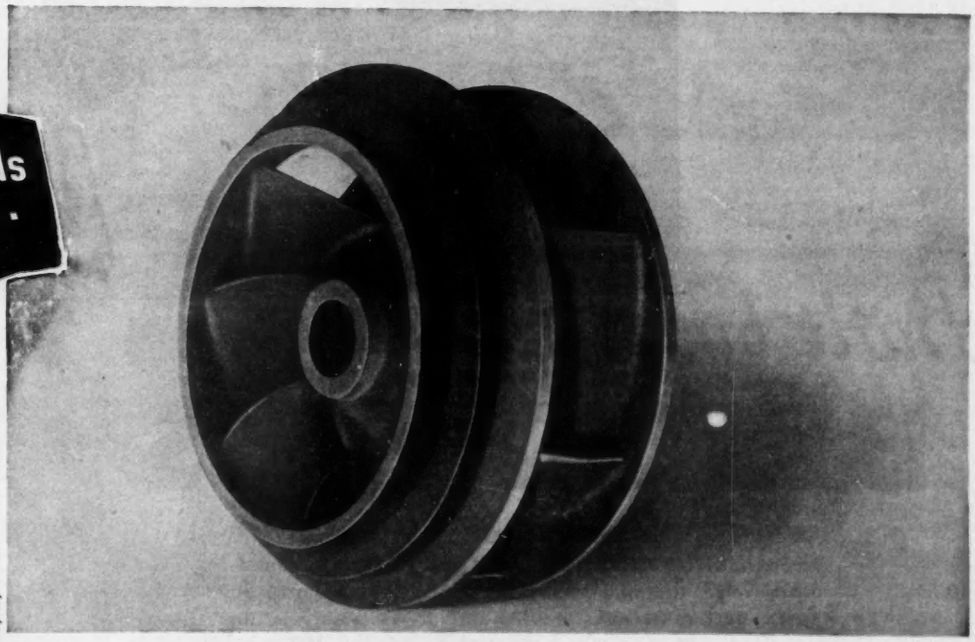


Stainless Steel Impeller



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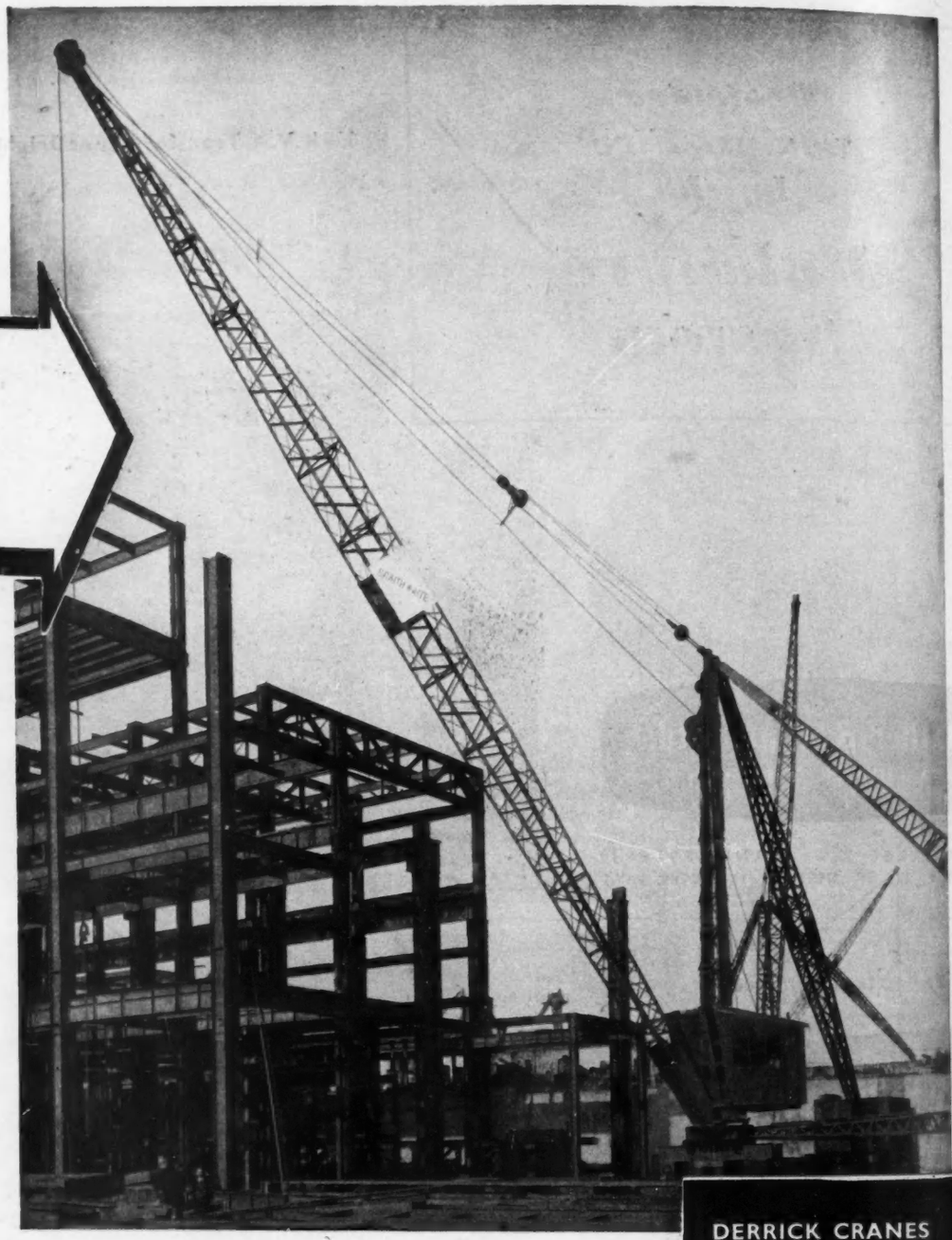

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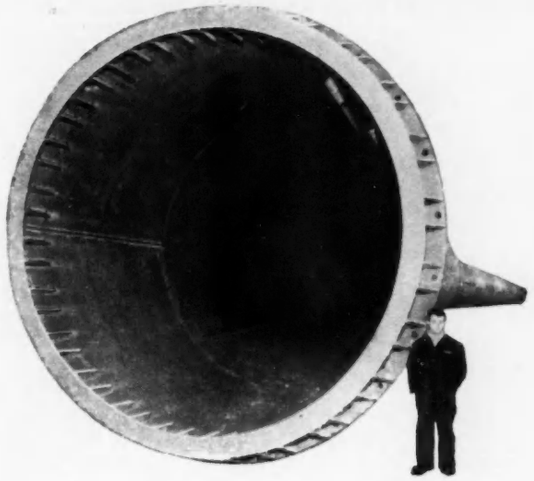

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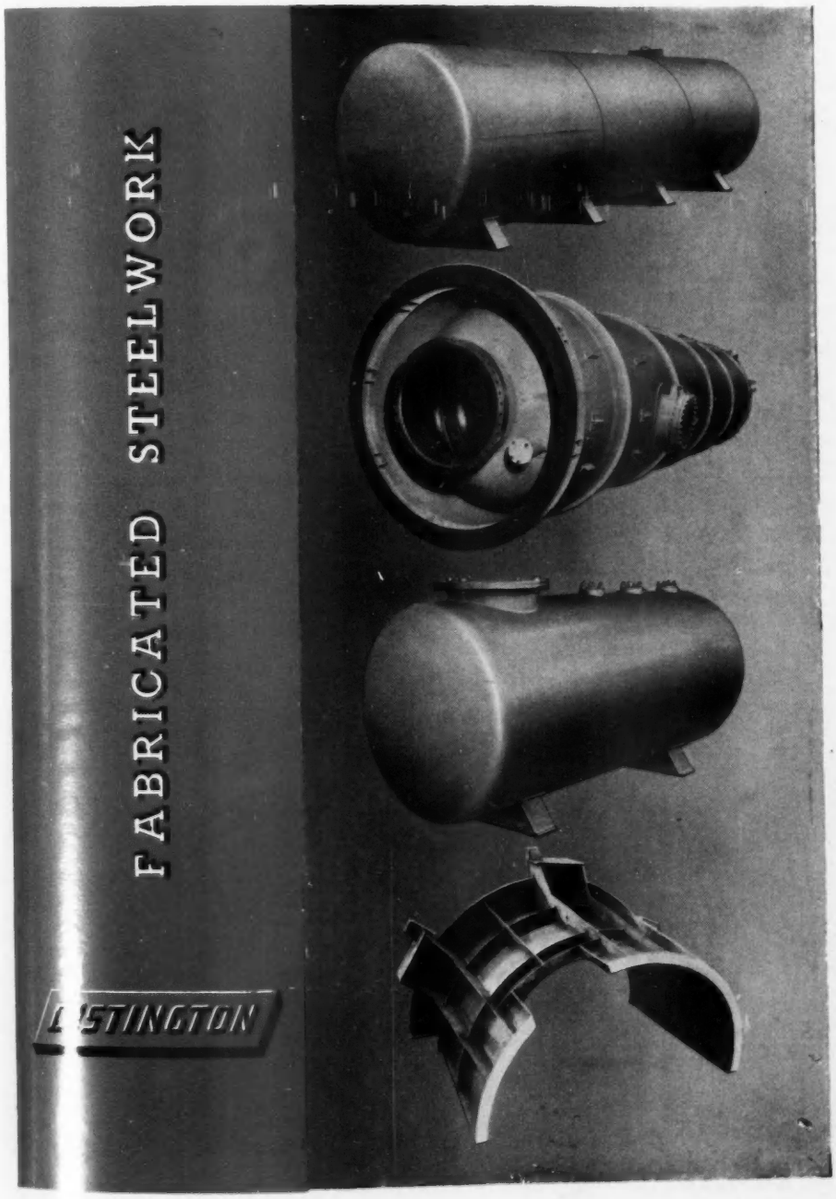

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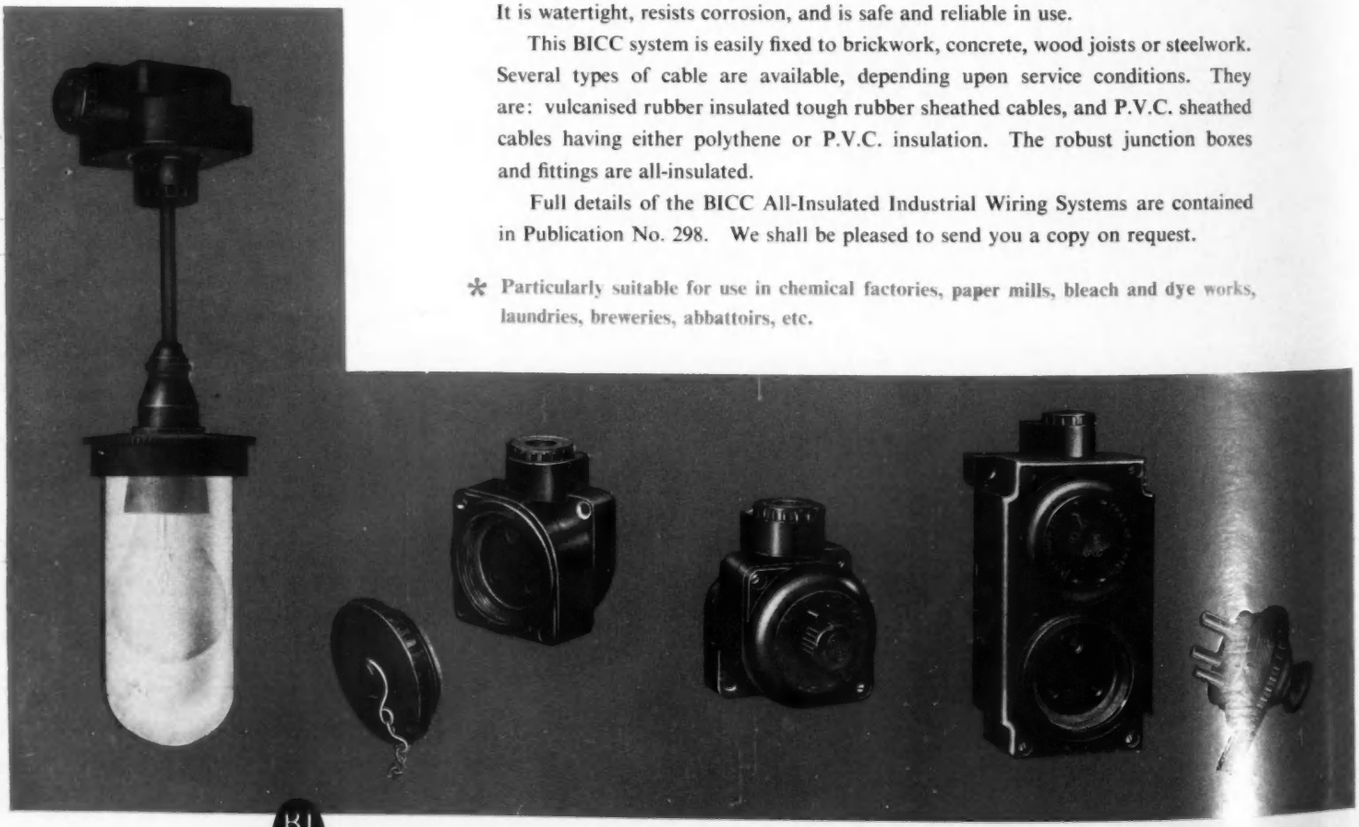

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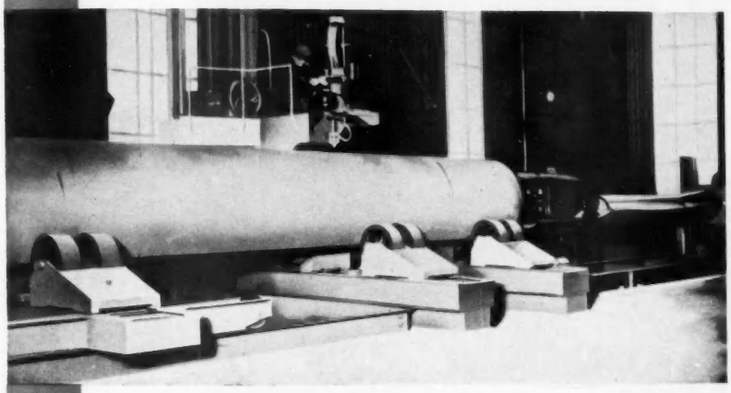

External and internal welding of Class 1 boiler drums, by the Fusarc process. Note the versatile cantilever—supported automatic welding head; boom-type internal welder (right) with effective welding traverse of 15′ 0″; and the adjustable motorised roller bed, working in conjunction with an idler-bed unit. All manufactured, installed and serviced by Quasi-Arc Limited—and only one of many complex automatic welding installations now in production.

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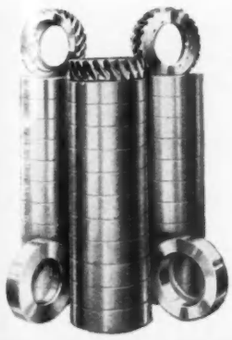

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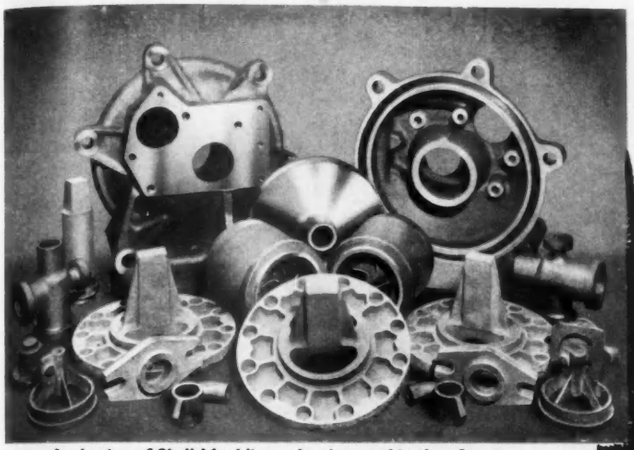

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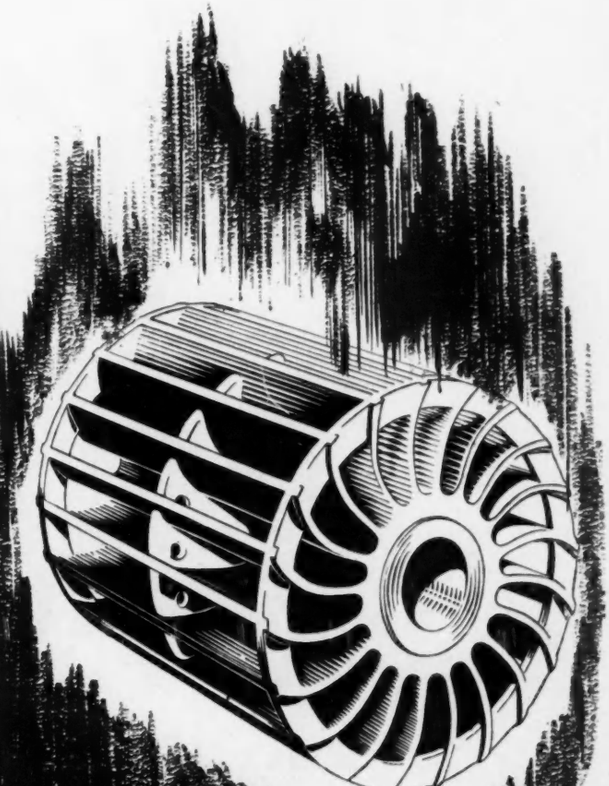

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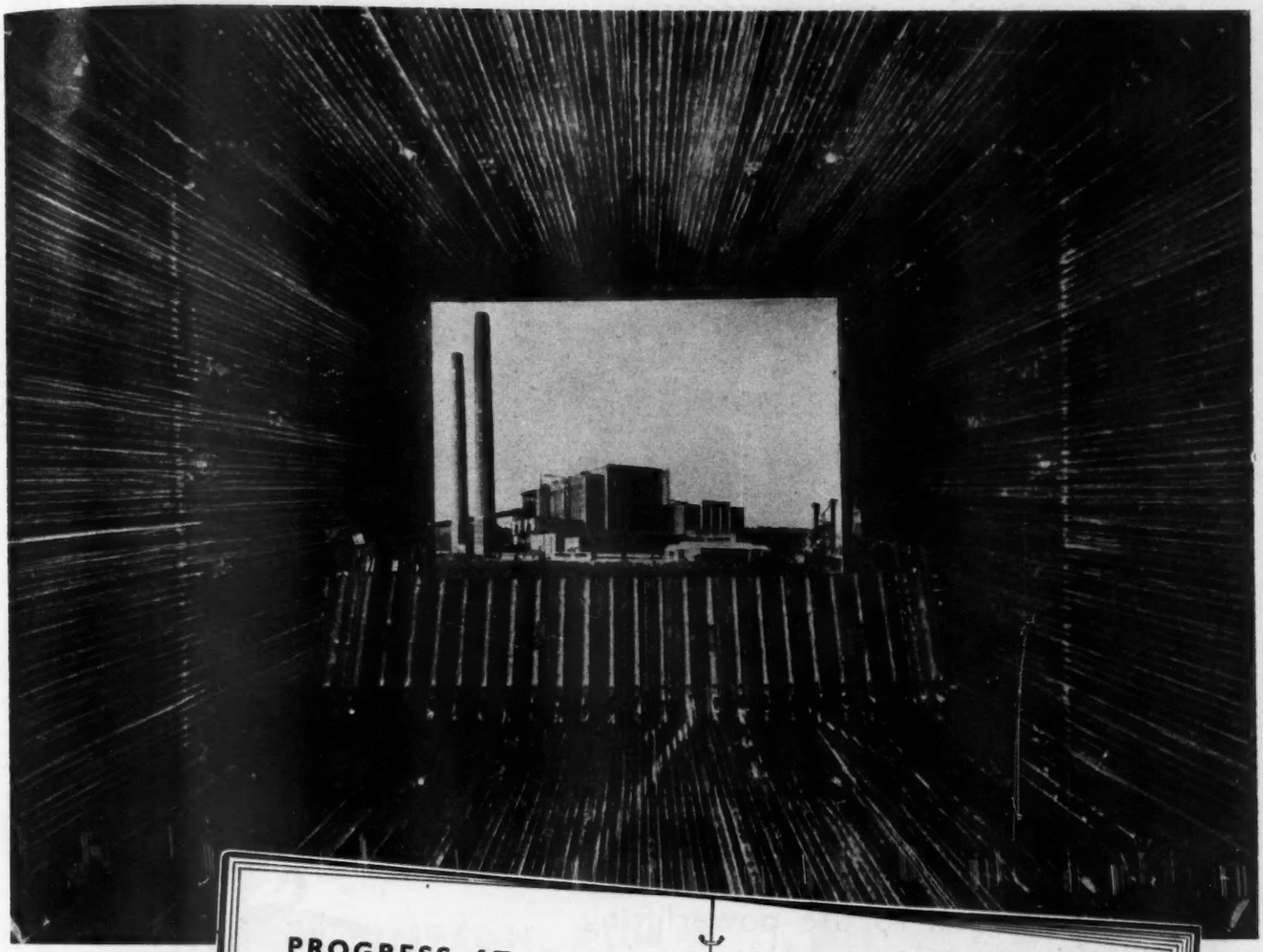

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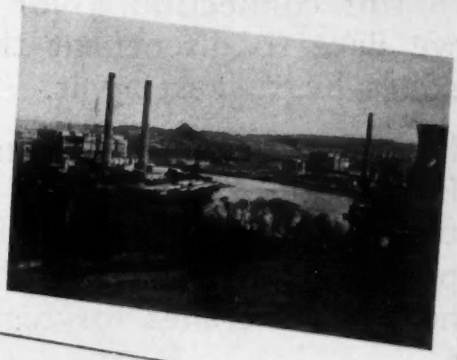

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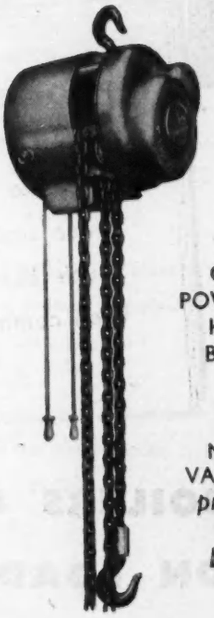

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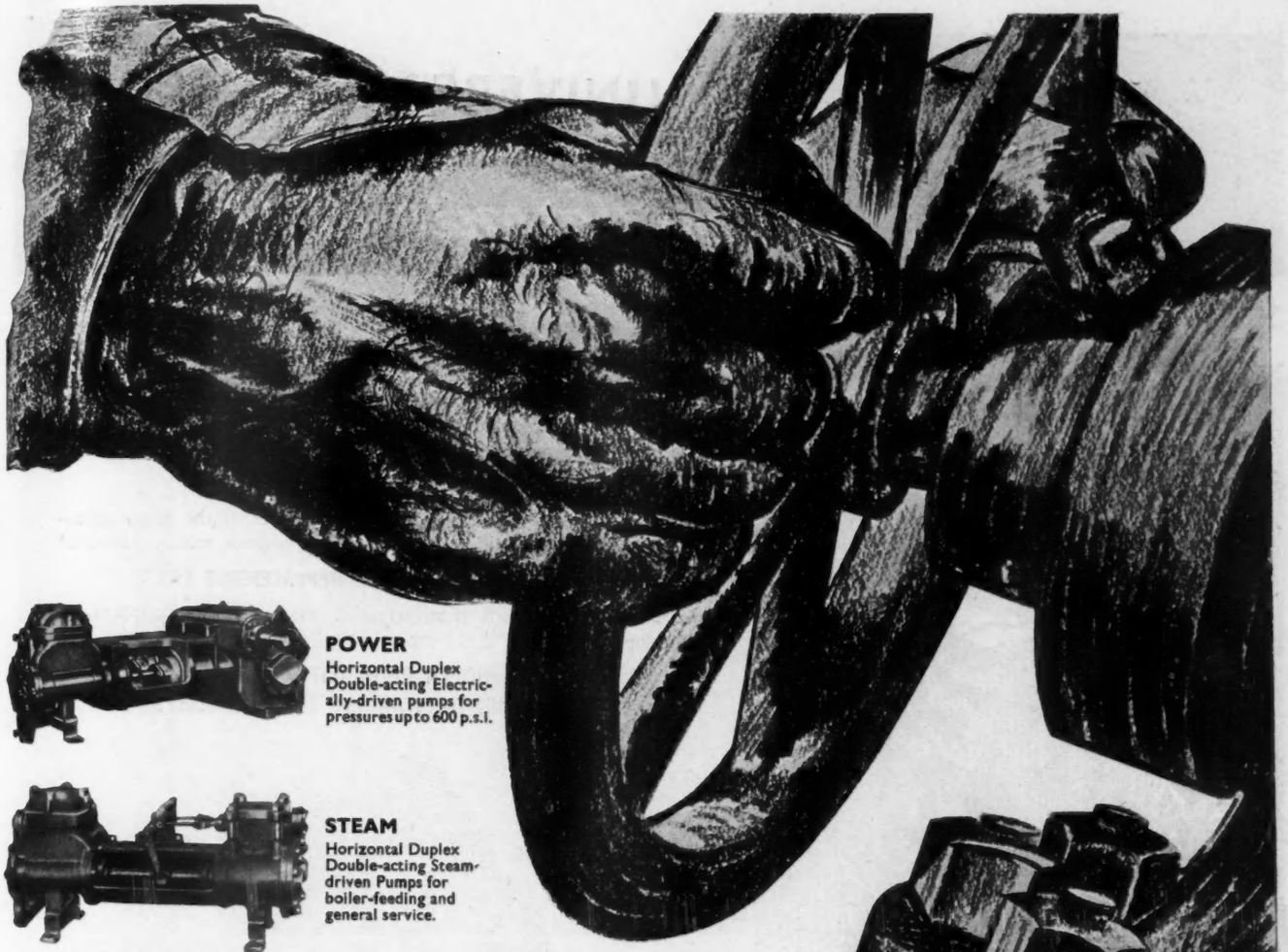

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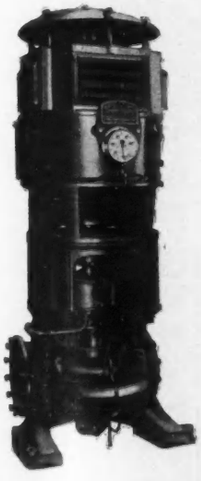

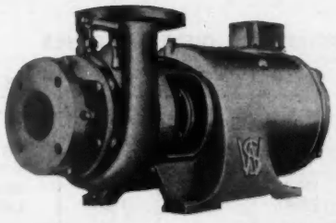

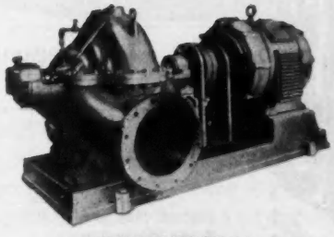

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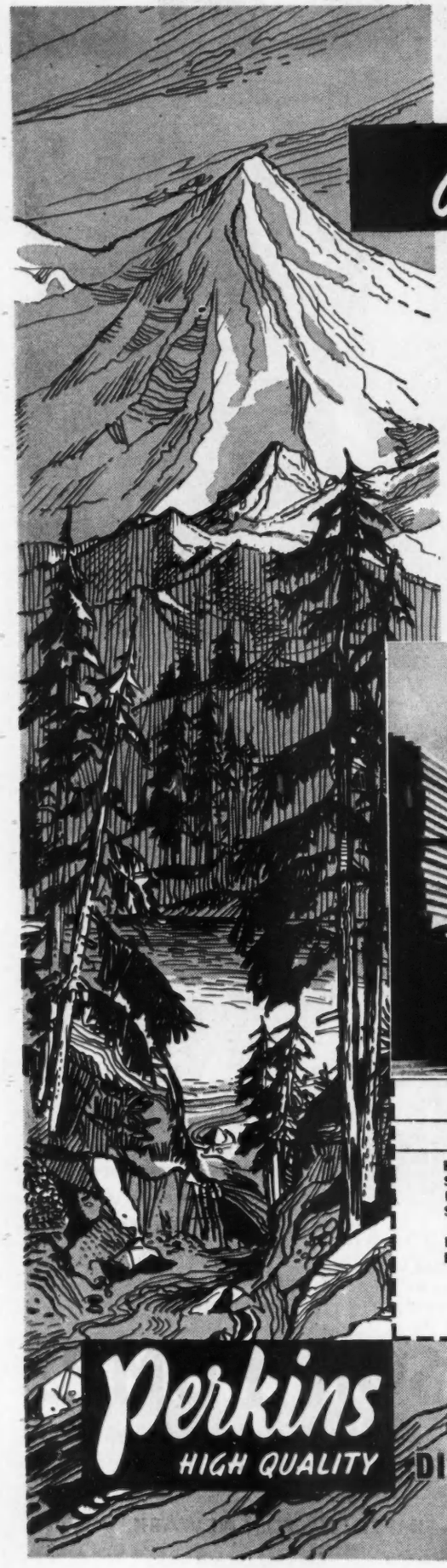

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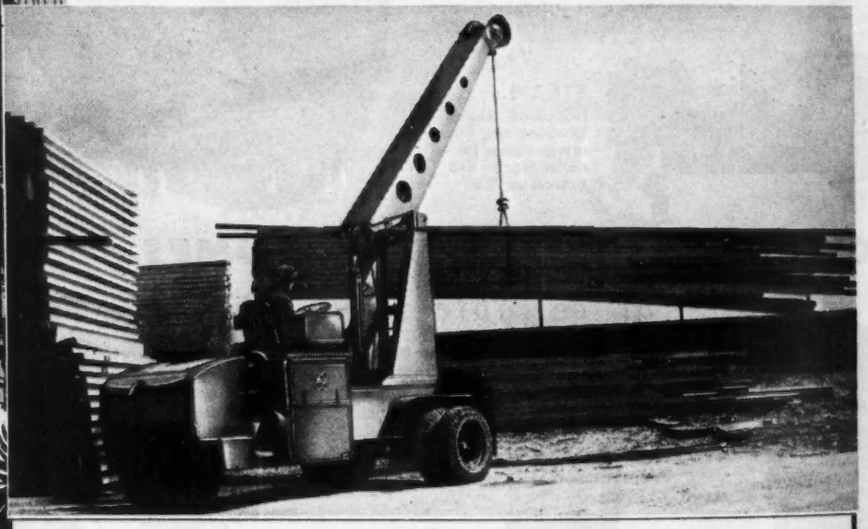
Experience of the demands of an extensive variety of power applications has developed a range of diesel engines of

PROVEN RELIABILITY,
LONG LIFE AND OUTSTANDING FUEL ECONOMY.



PERKINS INDUSTRIAL DIESEL ENGINES

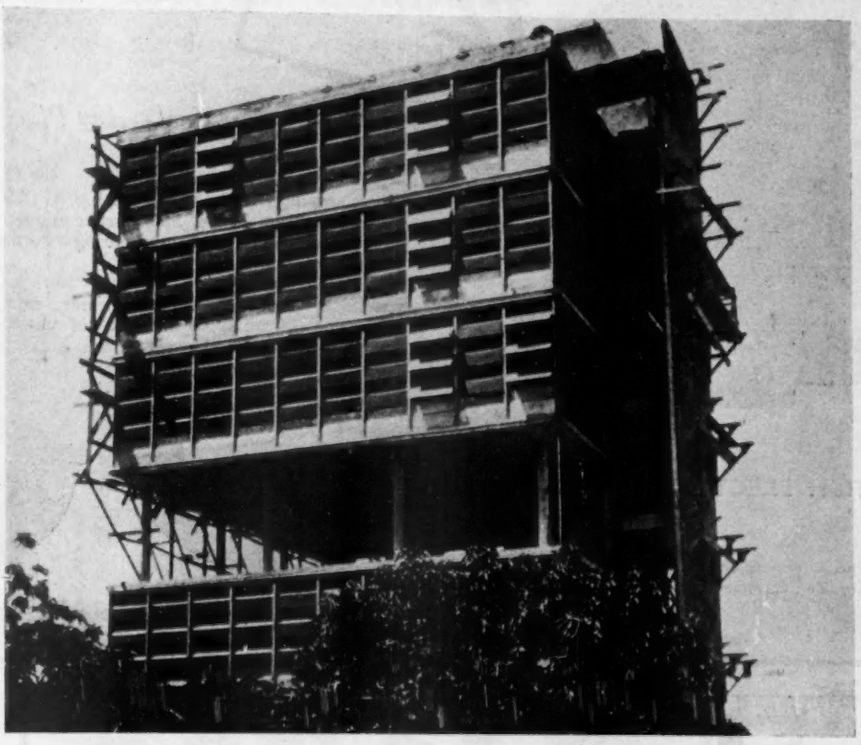
DETAILS	P3 (I)	P4 (I)	L4 (I)	P6 (I)	S6 (I)
Bore	3½"	3½"	4¼"	3½"	4⅛"
Stroke	5"	5"	4½"	5"	5"
No. of Cylinders	3	4	4	6	6
Swept Volume: Litres	2.36	3.14	4.42	4.73	7.36
Cu. ins.	144.3	192.4	269.5	288.6	450.8
Normal Max Speed R.P.M.	1,800	1,800	1,800	1,800	1,800
Brake Horse-powers:					
at 1,000 r.p.m.	15.75	21.5	31	32.75	51
1,200 ,,	19	26	37.5	39.75	61
1,500 ,,	24	32.5	46	49.75	76
1,800 ,,	28.25	37.5	53	57.5	89

(Based on 12-hour continuous operation under the specified conditions of B.S.S.649/1949)

Perkins
HIGH QUALITY

DIESELS ... *FOR INDUSTRIAL, VEHICLE, AGRICULTURAL AND MARINE APPLICATIONS*

F. PERKINS LTD., PETERBOROUGH - Phone: Peterborough 5341



CO-OPERATIVE BANK, ACCRA JAMES CUBITT, SCOTT & PARTNERS, *Architects*

HOPE'S

'Z' TYPE LOUVRES

PATENTED

seen above during installation on the east elevation: the west elevation is similar. 'Z' type louvres were designed to combat tropical heat and glare while providing full ventilation. They are ¾" thick with a metal outer skin, lined with insulating material, and are pivoted on weathertight bronze cup pivots. They are coupled for simultaneous operation and mechanically held in any position

HENRY HOPE & SONS LTD

Smethwick, Birmingham & 17 Berners St., London, W.1

AGENTS THROUGHOUT THE WORLD

MEMBER OF THE METAL WINDOW ASSOCIATION

MOTOR REWINDS & REPAIRS

Any Size - Any Place - Any Time

The above illustration shows a 200 h.p. 3·3 kV, 375 r.p.m. Underground Haulage Motor Stator, split frame, three-tier winding which was completely rewound during a normal holiday shut down period.

This is *not* an exceptional case—every week we are meeting similar deadlines. We specialise in rewinds, repairs, overhauls and conversions on all types and sizes of stators, rotors, armatures, transformers, etc., and our fourteen works are teamed to meet emergencies on a 24-hour day basis.

B.E.R.L **BRITISH ELECTRICAL REPAIRS LTD.**

Head Office: Empire House, Charlotte St., Manchester 1.
General Manager: A. Sorley, Tel: CENtral 1378 and 3641

For immediate service, contact our District Manager at any of the following works:- BATH, BIRMINGHAM, CARDIFF, CHESTERFIELD, EDINBURGH, GLASGOW, HAWICK, LONDON, MANCHESTER, NEWCASTLE, SWANSEA.

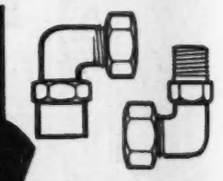
dm BE36

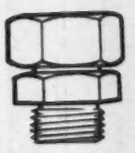
Simplifix

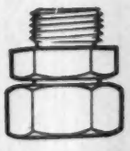
the well tried pipe joint

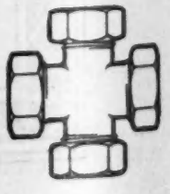
The Simplifix joint uses the well-tried principle of the compression coupling in its simplest and most efficient form. Simplifix joints can be made on almost any kind of tubing, including those with very thin walls.

Price List and Catalogue of Standard Fittings for O.D. Copper Pipe gladly sent on request.









SIMPLIFIX COUPLINGS LIMITED
HARGRAVE ROAD, MAIDENHEAD, BERKS
Telephone: Maidenhead 2271-4

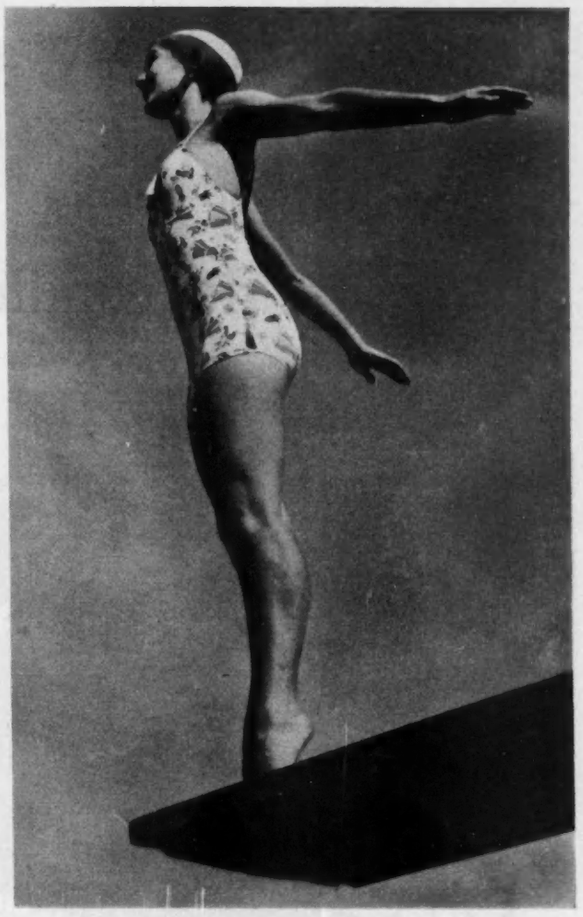
This advertisement is No. 10 of a series about famous buildings with Plenty Pumps on the heating installations.

PLENTY
PUMPS

PADDINGTON BATHS, LONDON

These famous swimming baths are heated by an oil-fired system, the fuel pumps for which consist of two Plenty pumps of 500 gallons per hour capacity. These pumps were supplied through Hubbard Combustion Ltd. in 1952, since when they have been giving efficient and trouble-free service.

Illustrated is a Standard Electrically-driven Oil-fuel pump. Suitable for all classes of fuel, including Creosote Pitch.



Write for full details to :

PLENTY & SON, LTD., Newbury, Berks

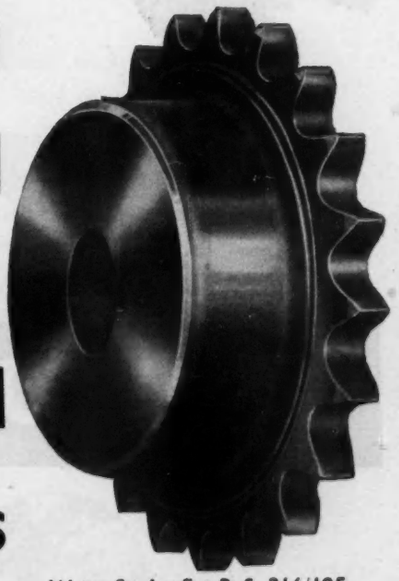
Telephone : NEWBURY 7 **Telegrams : PLENTY, NEWBURY.** E.

NOW! **RENOLD chain pinions**

ready bored and keywayed for standard shaft sizes

AN ADDITIONAL SERVICE

To make ***stock chain drives*** *even more easily available to the user, we now offer a range of stock pinions bored and keywayed (B.S. taper keyways), providing a range of alternative bore sizes.*



CHAIN PITCH	NUMBER OF TEETH	ALTERNATIVE STOCK BORE SIZES	B.S. TAPER KEYWAY
in.		in.	in.
·375 (No. 110 038)	17	·625	·1875
	19	·75	·1875
	21	1·0	·250
	25		
·5 (No. 110 046)	19	·75	·1875
	21	1·0	·250
	23	1·125	·3125
	25	1·25	·3125
·75 (No. 110 066)	19	1·0	·250
	21	1·25	·3125
	23	1·5	·375
	25	1·625	·4375

Write for Leaflet Ref. 216/195

STOCK PINIONS — FROM SHELF TO SHAFT!

RENOLD

RENOLD CHAINS LIMITED MANCHESTER

Something in the winding . . .

. . . makes the 'Clayton Still' Tube unique in the heat transfer field. The large dissipating surface, improved by air turbulence induced by the formation of the wire, provided a very high coefficiency of heat transfer. Result? Less tubing for any given job – and quicker, more efficient heat dissipation.

'Clayton Still' Tubes can be made for any application in lengths up to 15 feet. Density and formation of winding can be readily varied and the tube can be formed to any shape.

Our Engineers will gladly assist you to select the best tube for the job, and our free advisory service is available in any area.

'CLAYTON STILL' TUBES

IN INDUSTRY

ATOMIC ENERGY	FOOD PRODUCTION	BREWING
ENGINEERING	HEATING AND VENTILATING	ELECTRICAL GENERATION
CHEMICAL	RAILCAR	GAS PRODUCTION
MARINE	ROAD VEHICLE	REFRIGERATION
OIL REFINING	STATIONARY ENGINE	TEXTILE

CLAYTON DEWANDRE CO. LTD., TITANIC WORKS, LINCOLN, ENGLAND. TELEPHONE: LINCOLN 11305-9

S.T.10

Have you ever seen another compressor with all these features?

Check this list and see how ARPIC scores every time!		ARPIC 120 FD	Other Makes
LUBROMATIC CLUTCH	Independent of centrifugal force and therefore cannot slip—positive starting action through a simple hand control.	✓	
FUELMISER	Regulates engine speed to air demand —30% saving in fuel consumption, and reduces wasteful unloader operation.	✓	
ELECTRIC STARTING	Simple and safe mechanical engagement starter—more reliable than exhausting hand cranking.	✓	
POSITIVE DISPLACEMENT OIL PUMP	Permanently primed—high pressure lubrication including small ends at all running speeds.	✓	
OVALISED PISTONS	Gives uniform expansion—electrolytically tin plated to give reduced clearance and safer and better 'run in'.	✓	
OIL BATH FILTER	Cleanses all inlet air of abrasive dust and dirt—pistons last longer.	✓	
AUTOMATIC BRAKES	Efficient, double safety feature for highway or cross country towing—parking brake provided.	✓	
ENDERISED BODY	Prevents rust—spray finished in oil and weather resistant high gloss enamel.	✓	

Arpic Engineering, Queenslie Estate, Glasgow, E.3, Scotland
Chaussee de Boom, Wilrijk, Antwerp, Belgium

Powered by- FORD DIESEL

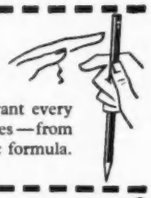
Years of research and study of operators' needs have gone into the design of this machine. It is engineered to give long and efficient service under all working and climatic conditions. Compact, lightweight yet robust, and backed by a world-wide service organisation, the owner is assured of reliable and economical performance for the maximum length of time. Write today for details of ARPIC compressors, and of the ARPIC Agent in your area.

ARPIC
ENGINEERING Ltd

TURQUOISE wins on every point

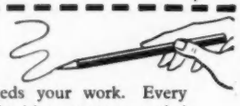
EAGLE "CHEMI-SEALED" TURQUOISE DRAWING HB

PRECISION GRADING



Turquoise gives exactly the line you want every time, because every one of the 17 grades—from 9H to 6B—is made from its own basic formula.

SMOOTHNESS



Turquoise smoothness speeds your work. Every particle of lead is lubricated with rare waxes, sealed in for permanent smoothness. No gritty flaws, no harshness.

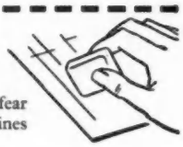
OPACITY

100% Electronic graphite refined in the Eagle attrition mill to 1/25,000th" particles, produces a fine-textured lead that gives lines of maximum denseness for perfect reproduction.

STRONG POINTS

Turquoise points don't snap or crumble under pressure. The more compact lead—100% Electronic graphite again—takes and holds a needle point without crumbling.

CLEAN ERASURE



With Turquoise pencils there is no fear of "ghost" lines after erasure. Lines rub out cleanly every time.

EAGLE

'CHEMI-SEALED' Super-bonded

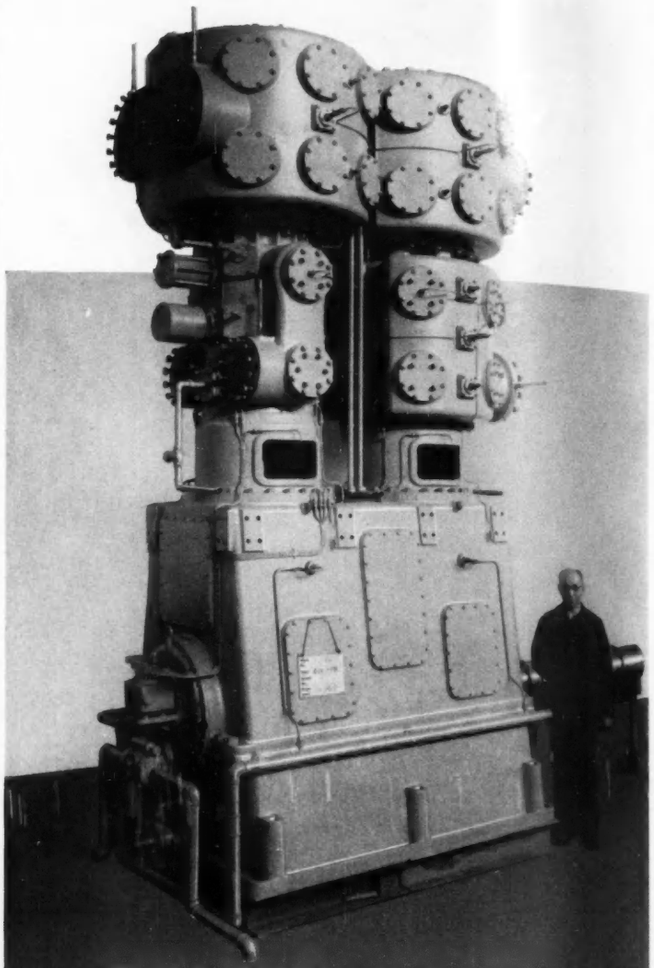
TURQUOISE

DRAWING PENCILS

with 100% 'ELECTRONIC' *Graphite*

T6

EAGLE PENCIL COMPANY, ASHLEY ROAD, TOTTENHAM, N.17



COMPRESSORS *for* INDUSTRIAL GASES

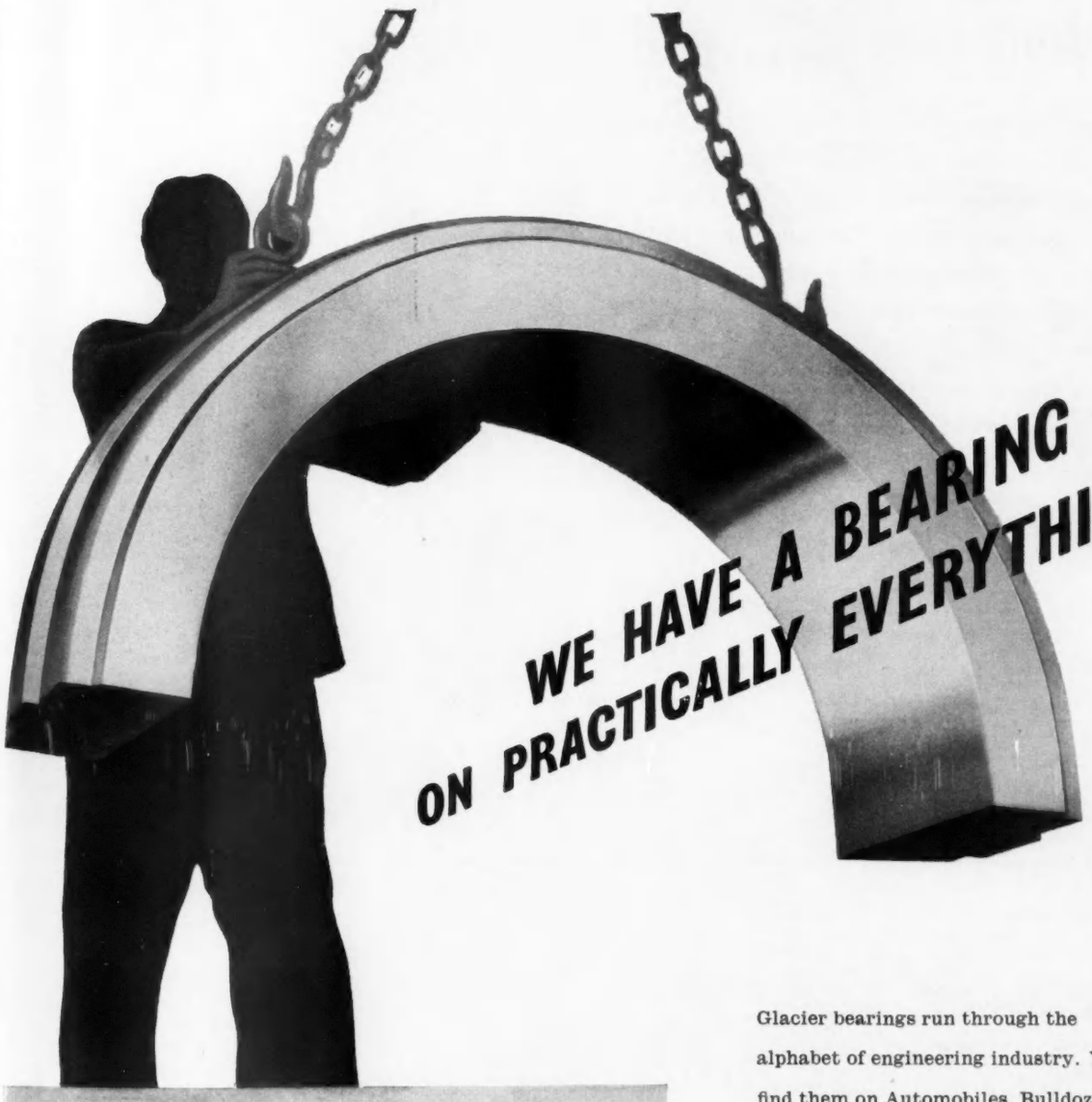
Moderate speed compressors carefully designed for reliability, are available in both vertical and horizontal form from small units up to units of over 5000 h.p. and very high pressures.

Illustrated is a vertical twin crank three stage compressor with a capacity of 6000 cubic metres per hour at 290 r.p.m. and a delivery pressure of 20 atmospheres.

Lloyd & Ross Ltd

58, Victoria Street, S.W.1. Telephone Vic 4873

Maschinenfabrik Esslingen Germany



WE HAVE A BEARING ON PRACTICALLY EVERYTHING

THE GLACIER ORGANISATION

3 production factories, 3 service stations; over 347,000 square feet of floor area, employing nearly 3,000 people, serving thousands of customers in engineering and many other industries all over the world.

Glacier bearings run through the alphabet of engineering industry. You'll find them on Automobiles, Bulldozers, Compressors, Diesels, Electrical generating plant—to mention a few . . . In size, they vary from $\frac{1}{8}$ths of an inch to 4 feet bore diameter. In value, from twopence to £200 each. Glacier, in fact, stands for *all* plain bearings.

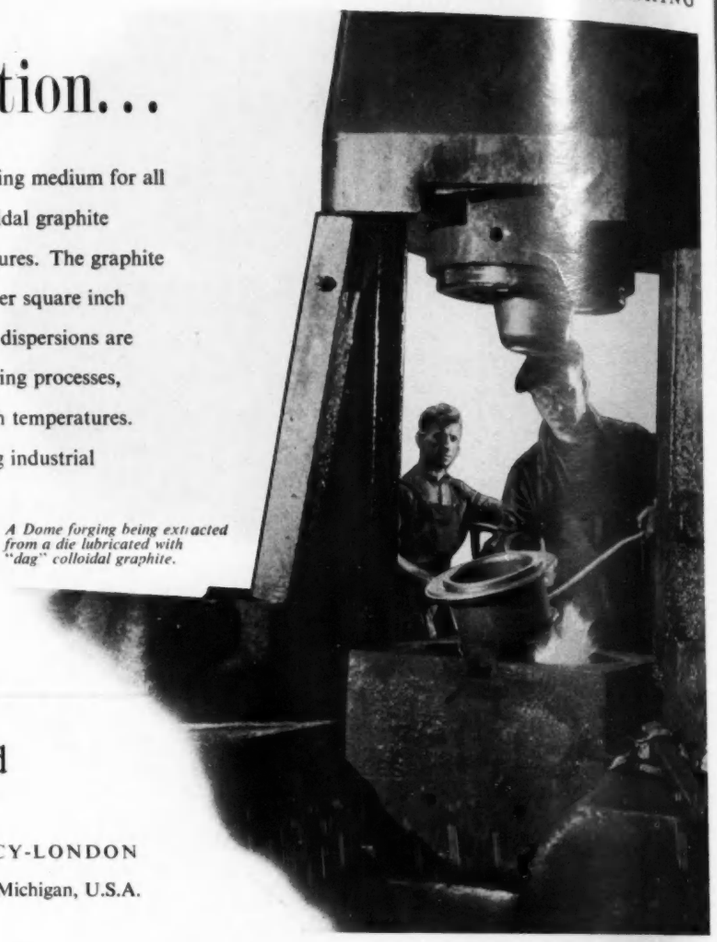
GLACIER

the largest makers of plain bearings in Europe

THE GLACIER METAL COMPANY LIMITED. ALPERTON, WEMBLEY, MIDDLESEX, ENGLAND

for efficient die lubrication...

"dag" colloidal graphite is the perfect lubricant and parting medium for all metal-forming operations. Dies treated with "dag" colloidal graphite offer maximum resistance to high temperatures and pressures. The graphite coating is capable of withstanding loads of several tons per square inch and greatly improves slip between metal and die. "dag" dispersions are equally effective for casting, extrusion and other engineering processes, and for the lubrication of all equipment operating at high temperatures. The benefits of our 40 years' experience in manufacturing industrial dispersions are freely at your disposal.



A Dome forging being extracted from a die lubricated with "dag" colloidal graphite.

dag
REGD TRADE MARK
DISPERSIONS

Acheson Colloids Limited

18 PALL MALL, LONDON, S.W.1

Telephone: WHI 2034-9 *Telegrams:* OILDAG-PICCY-LONDON

Also ACHESON COLLOIDS COMPANY, Port Huron, Michigan, U.S.A.

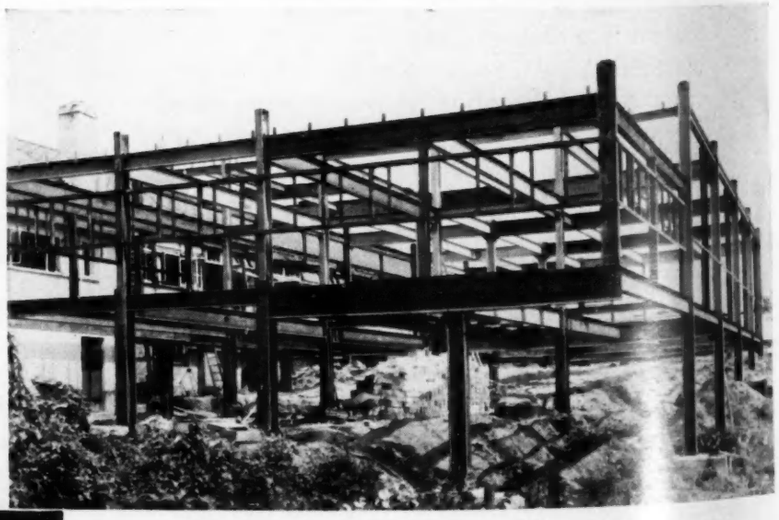
Talking about . . .

STRUCTURAL STEELWORK

For many years SHEPPARD'S of BRIDGEND have been supplying and erecting steelwork for frames of all types of buildings—single or multi-storey—and have built up a reputation with Consulting Engineers and Architects alike.

A recent example of SHEPPARD structural steelwork is illustrated . . . a steel frame of approximately 74-tons for factory extension for Messrs. **DEVON LEATHER-CRAFTS LTD., Newton Abbot.**

Architects	**Locke, Son & Newcombe, L./A.R.I.B.A., Newton Abbot.**
Consulting Engineer	**Clifford E. Saunders, M.I.Struct.E., A.M.Inst.W., Bristol.**
Contractor	**T. B. Keate & Co., Exeter.**



why not talk to

SHEPPARD IRONFOUNDERS, HEAVY GENERAL STRUCTURAL & MECHANICAL ENGINEERS *about it!*

SHEPPARD & SONS LTD. BRIDGEND . Tel.: [illegible]END 567 (5 lines) 'Gram[illegible]' 'SHEPPARD' BRIDGEND.

it's here...
HYDRAULIC
LUFFING !

. . . . . in the latest and most up-to-date high speed cargo handling crane in the world.

The Clyde L.H.L. is essentially an electric crane but uses hydraulic fluid as a transmission medium for operating the jib.

The illustration pin-points the hydraulic luffing ram which is controlled by a compact electro-hydraulic unit in the machinery house. This system reduces the number of moving parts, takes up less room and is remarkable for its smoothness and speed of action ; it is in fact the modern solution to the problem of operating a high speed luffing motion.

May we furnish you with a general specification or arrange a demonstration.

CLYDE BOOTH
CRANES

CLYDE CRANE & BOOTH LTD.
incorporating

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire.
Telephone : Motherwell 354/5. Telegrams : "Clyde," Motherwell.

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MODERN GAS CLEANING—1

ask yourself these questions

1. WHAT IS ELECTRO-PRECIPITATION ?
2. WHAT ARE ITS APPLICATIONS ?
3. HOW EFFICIENT IS IT ?
4. WHAT DOES IT DO TO THE MATERIAL ?
5. WHAT CAPACITY CAN BE DEALT WITH ?
6. HOW MUCH SPACE IS NEEDED ?
7. HOW RELIABLE IS IT ?
8. HOW MUCH DOES IT COST ?

If you are concerned at all with problems of dust extraction for the prevention of pollution or in industrial recovery processes, you should know the answers to these key questions about the latest electro-precipitation techniques. Take time now to check on the facts you should know. The answers to these questions are printed in the panel below and we will be pleased to answer your further questions on electro-precipitation.

Before you read this . . .

1. It is a means of removing solid or liquid particles from a gaseous carrying medium. It does this by charging the particles in an electric field and precipitating them on to a receiving surface.

2. It is a highly efficient means of collecting dusts, mists and fumes from most chemical and industrial processes.

3. Efficiencies of more than 99 per cent. are commonly achieved nowadays. This applies to particles of all sizes, not just those in the larger range.

4. As a rule, the material is recovered in its original state. In the cases where wet precipitators are more suitable, the material is collected as a liquid or sludge.

5. This ranges from a few hundred to several hundred thousand cubic feet per minute of gas.

6. This depends on the gas volume, but an important aspect of our design is its flexibility. Simon-Carves plants can be arranged for horizontal or vertical gas flow and the proportions can be varied to suit local conditions.

7. Simon-Carves plants are robustly constructed and are designed to cope with fluctuating gas conditions with constant efficiency throughout the life of the plant. Wear and tear on the plant is very low and replacements are very infrequent.

8. Capital costs are not high considering the superior performance of electro-precipitators whilst running and maintenance costs are far less than for other types of high-efficiency collectors.

High efficiency electro-precipitation

by Simon-Carves Ltd SIMON ENGINEERING GROUP

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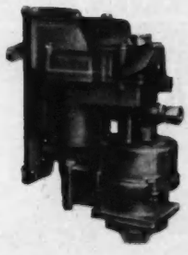
Makers of

The WIDEST STEEL SHEETS

SMITH & McLEAN · LTD
179 WEST GEORGE ST · GLASGOW · C·2
'PHONE CENtral 0442 · 'GRAMS "CIVILITY" GLASGOW

Ardleigh Governors

FOR DIESEL ENGINES
AND OTHER PRIME MOVERS



Ardleigh Engineering Ltd

LANGHAM NR. COLCHESTER ESSEX

TELEPHONE COLCHESTER 3209

MANCUNA

RUBBER CRASH DOORS

Now in sizes up to 20 ft. and over

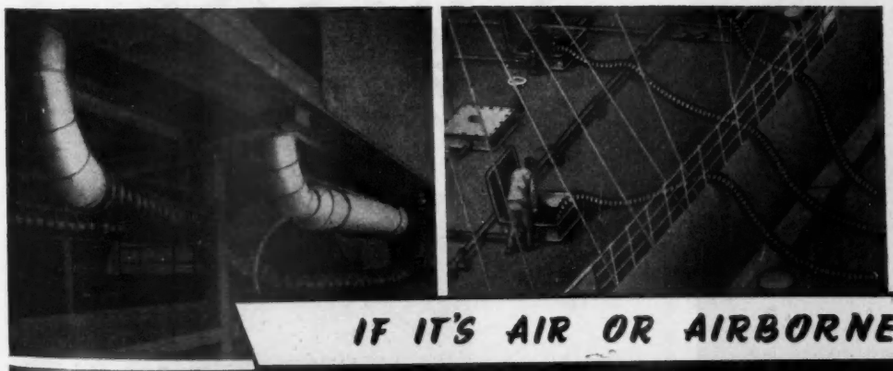
Rubber crash doors solve the problem of mechanical-handling vehicles and road vehicles driving into the works. They keep the draught out and the heat in and avoid damage to doors and vehicles with a minimum of maintenance.

Standard Internal doors up to 10ft. by 10ft. Heavy-Duty External doors up to 14ft. by 20ft. made from special $\frac{1}{16}$ in. or $\frac{1}{2}$in. 9-ply rubber.

The Illustration shows one of two heavy-duty doors installed for the Northern Aluminium Company Limited, Rogerstone, Newport, Mon.

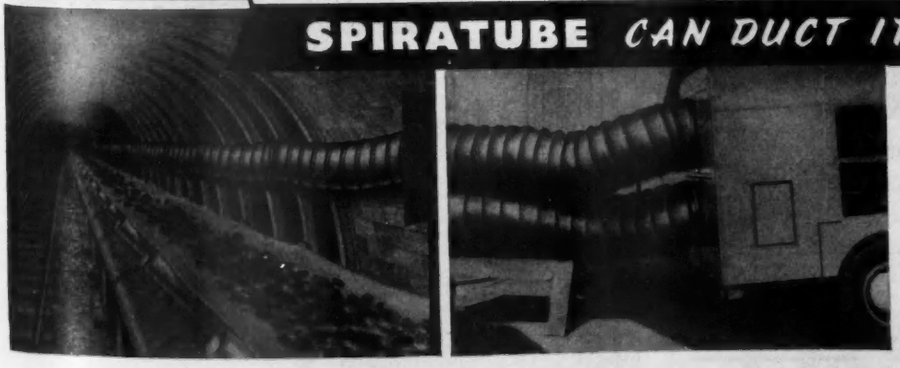
MANCUNA ENGINEERING LIMITED

Denton, Manchester Telephone: DENton 39655 (5 lines) Also at London, Edinburgh, Birmingham, Bath, Leeds.



IF IT'S AIR OR AIRBORNE

SPIRATUBE *CAN DUCT IT*



Light materials or abrasive dust—acid fumes or combustion exhaust . . . it's a job for SPIRATUBE—the versatile flexible ducting that many leading industries are now specifying as standard equipment.

SPIRATUBE is installed quickly and easily with no costly structural alterations, heavy hangers or special fitments. Economical, too, because SPIRATUBE can be dismantled and used again and again. SPIRATUBE won't kink, or buckle, even when taken around sharp bends or along twisting passages. SPIRATUBE is light, tough, flexible, retractable and is available in a range of diameters from 3" to 30".

Write today for the SPIRATUBE Brochure which illustrates what this versatile ducting will do. Put your problem up to our Design Engineers. They will be glad to advise you without cost or obligation. The address is Flexible Ducting Limited, Maryhill, Glasgow.

FLEXIBLE DUCTING LIMITED, MARYHILL, GLASGOW, N.W,

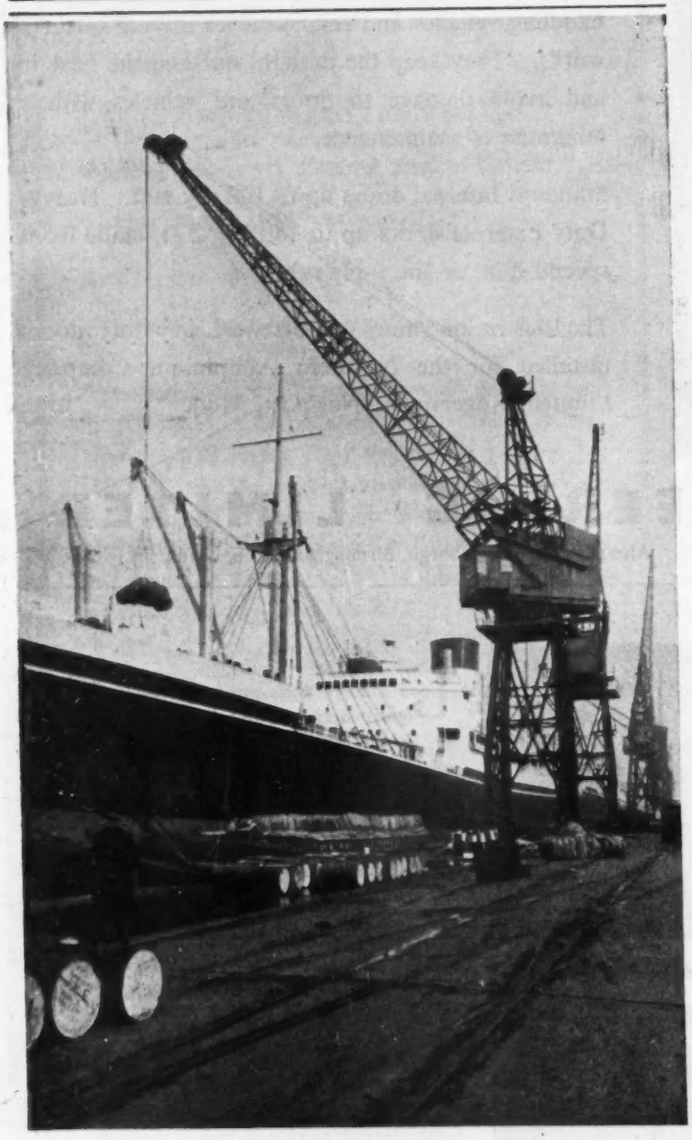
Telephone: MARyhill 3729 Telegrams: Flexiduct,Glasgow, N.W.

AN ASSOCIATE COMPANY OF GEORGE MACLELLAN & CO. LTD

ESTABLISHED 1870

S

LONDON

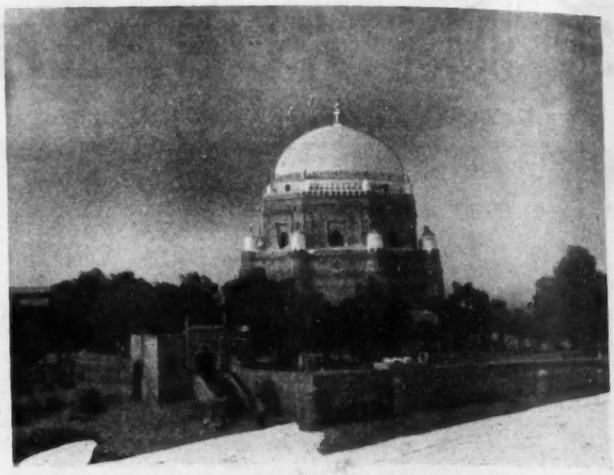


3- & 5 TONS AT 80 FEET RADIUS

EST S&P 1820 LIMITED

STOTHERT & PITT LTD

ENGINEERS • BATH • ENGLAND



Saints' Tomb, outside Colony Textile Mill, Pakistan.

Where water is scarce and heat intense, " Visco " Steel Shell Forced Draught Water Coolers are invaluable. Thousands of these neat units are used for cooling diesels, compressors, refrigerating plant, air conditioning, etc. Their great advantage is that the water used for cooling is recirculated continuously, without waste, except for about 3 per cent. lost by evaporation.

The illustrations below show four of these units cooling Blackstone engines driving alternators at a cotton mill in Pakistan. The coolers, each 2,450 g.p.h., are enclosed in wood to protect them from the direct rays of the tropical sun.

" Visco " Steel Shell Coolers are available in any capacity from 250 to 120,000 g.p.h. Write for List No. 514.

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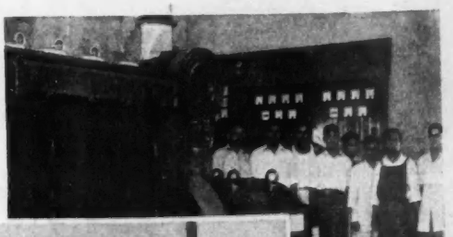
One of 4 Blackstone diesels mentioned above. Photos by courtesy of Blackstone & Co. Ltd.



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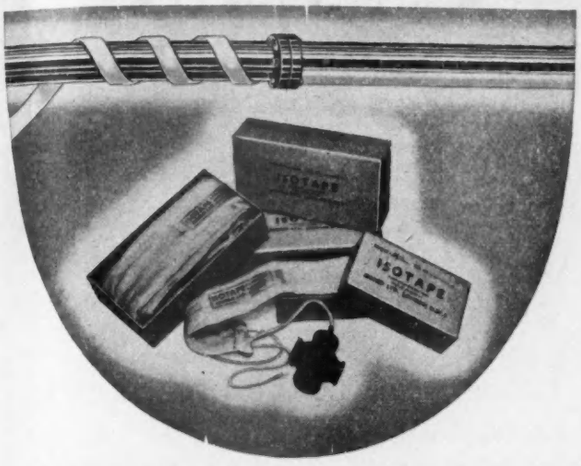

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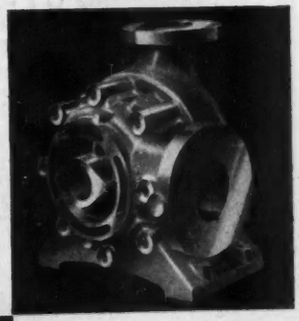

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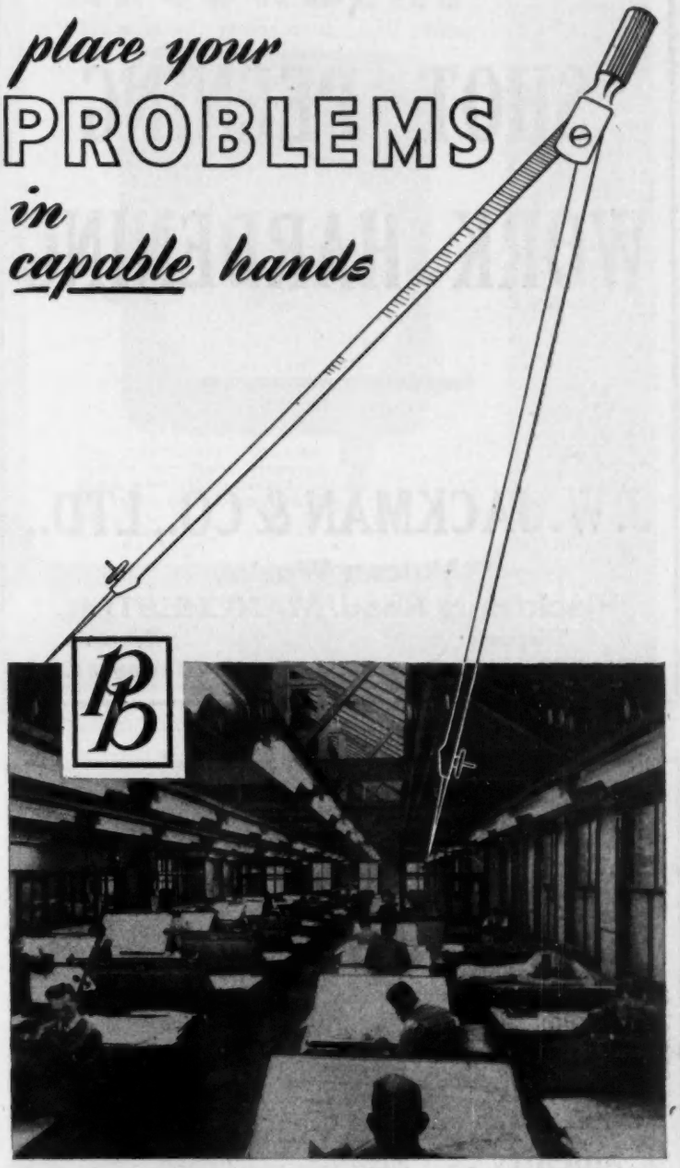

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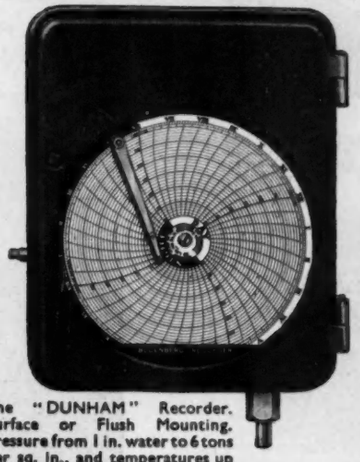

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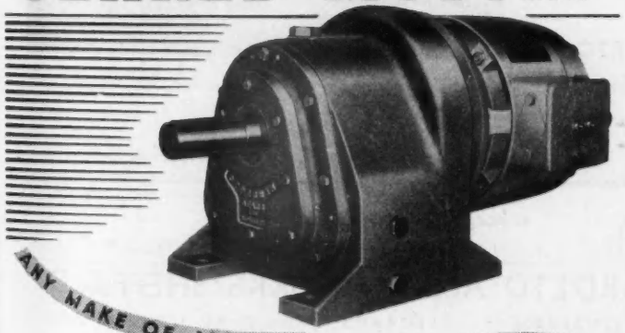

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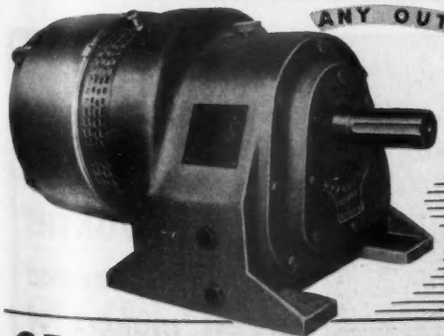

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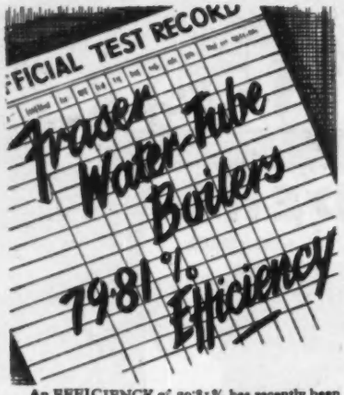

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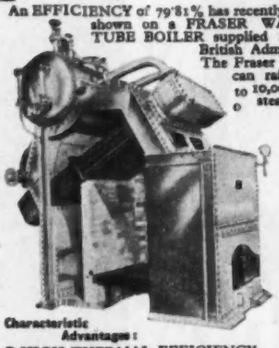

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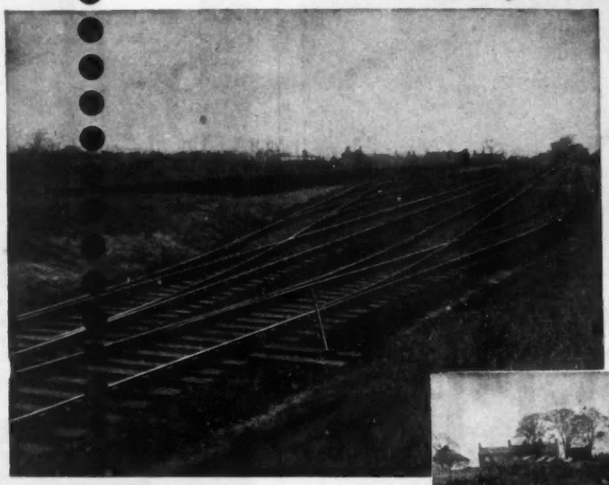

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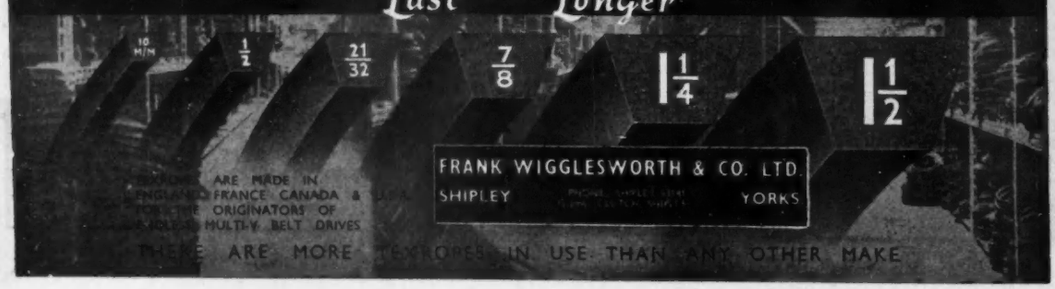

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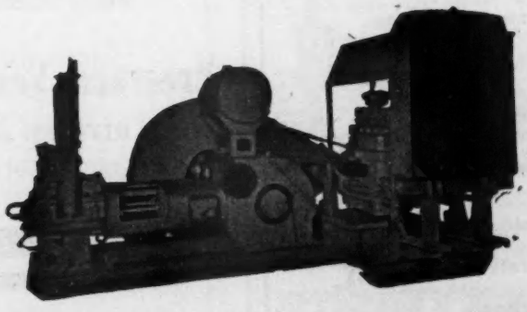

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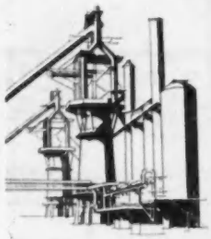

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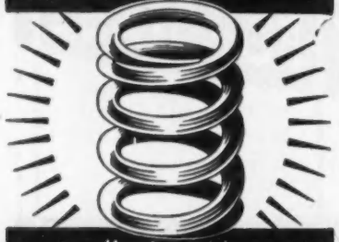

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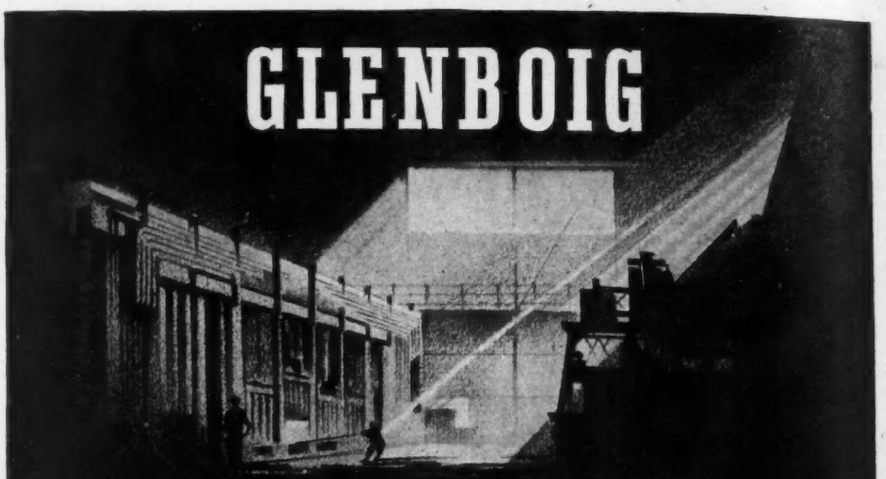

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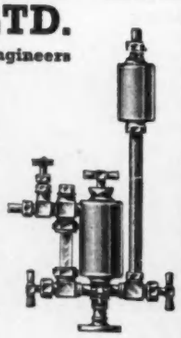

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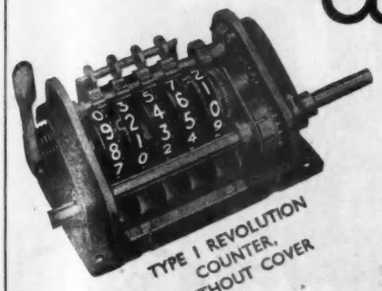

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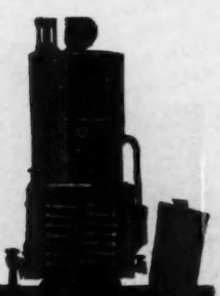

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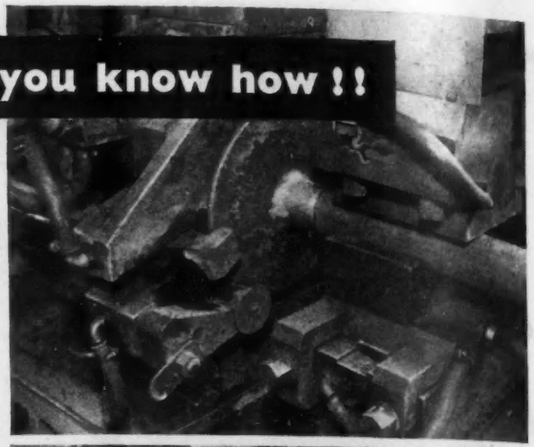

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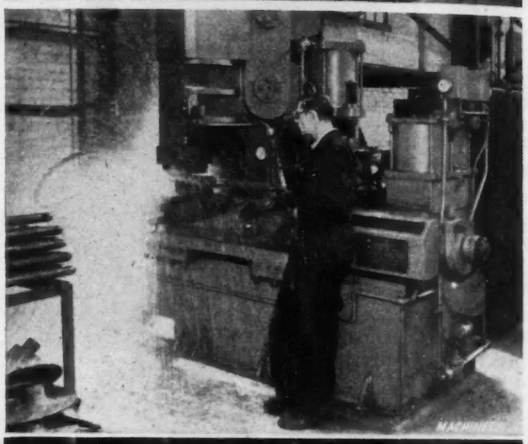

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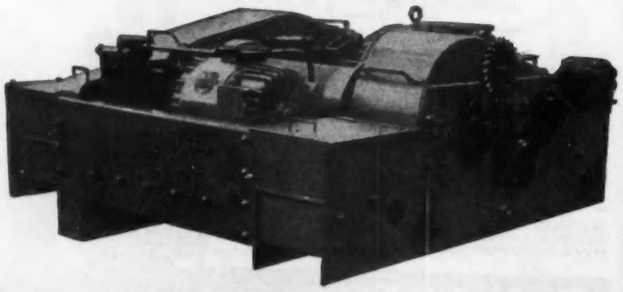

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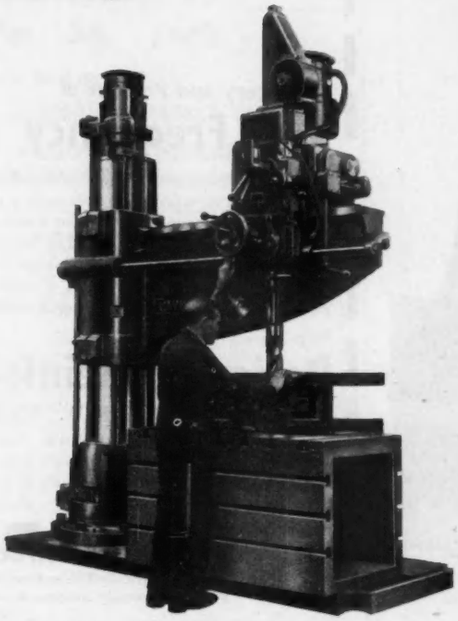

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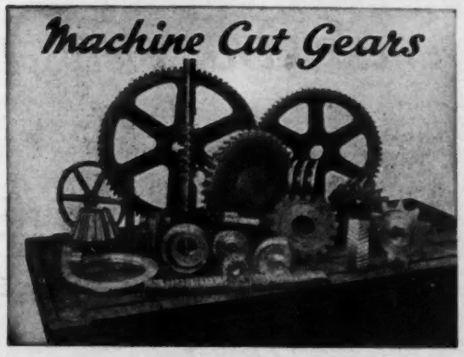

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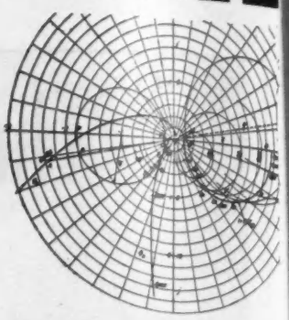

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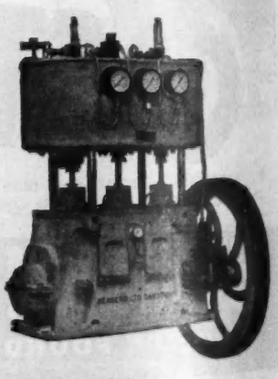

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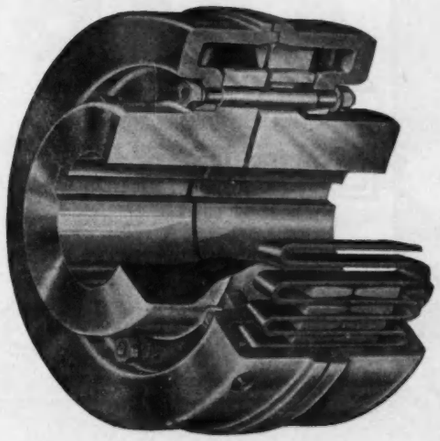

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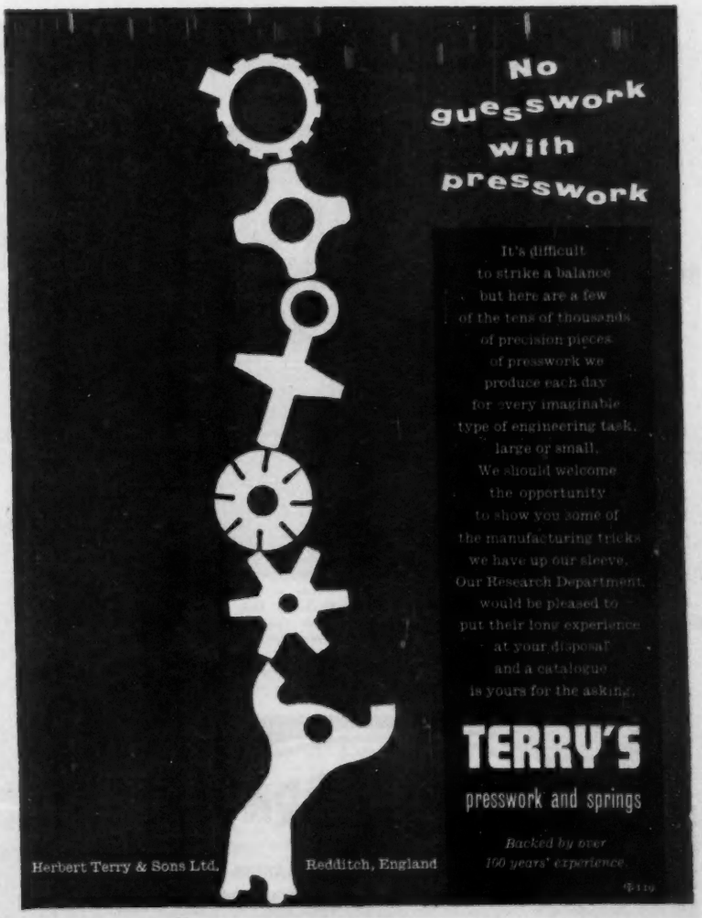
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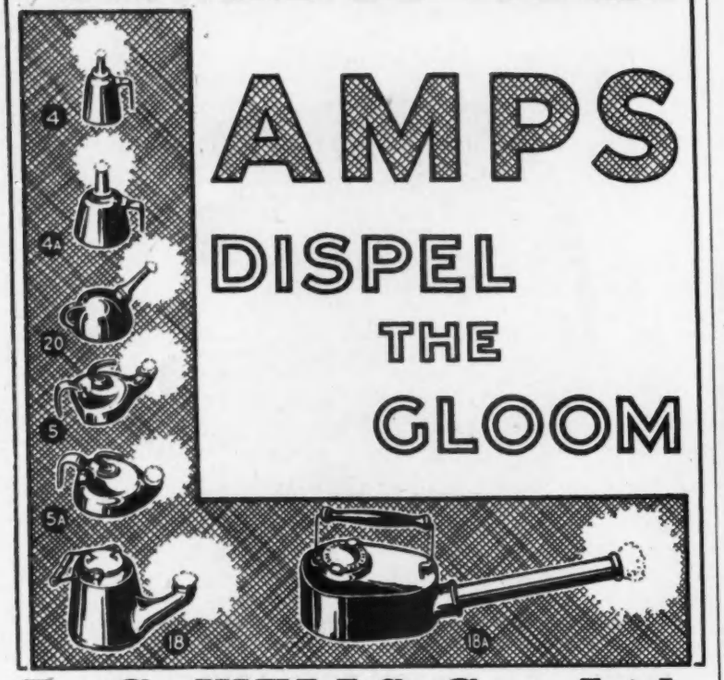

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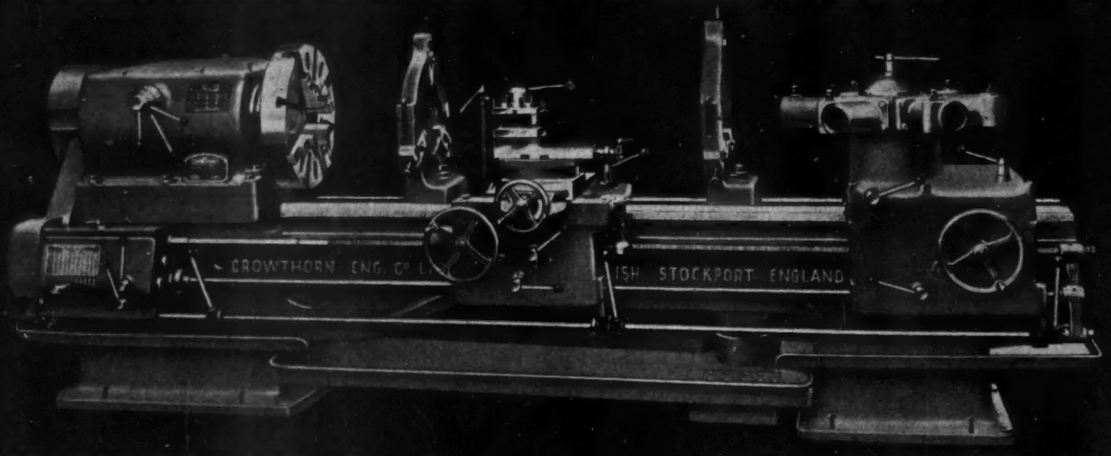

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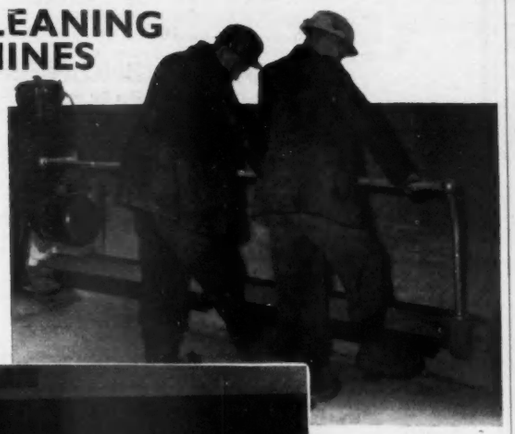

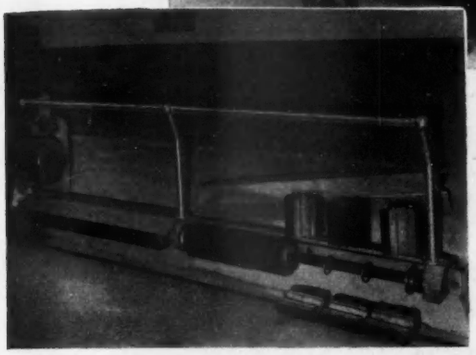

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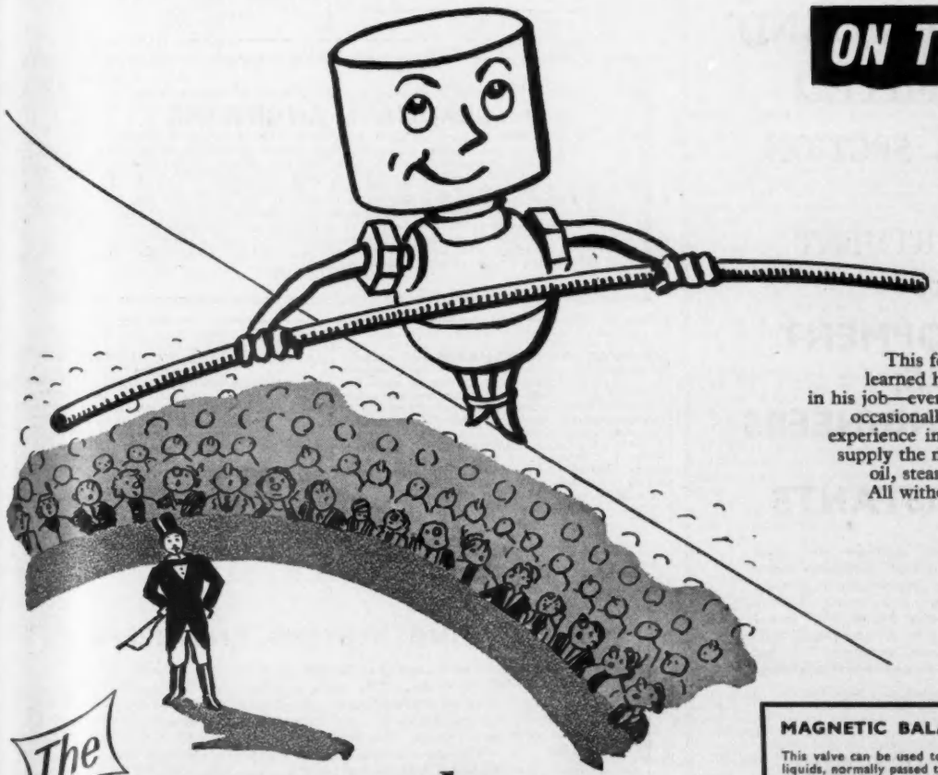

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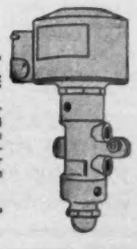

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ELECTRICAL LABORATORY ASSISTANT. Young men are required for prototype work on low voltage equipment for motor vehicles. Applicants should hold, or be studying for, O.N.C. (Electrical), although practical experience in similar work would be considered in its absence. Prospects of advancement into Design work exist for the right man.

Apply in writing giving full details of age and experience to PERSONNEL OFFICER, SIMMS MOTOR UNITS, LTD., OAK LANE, EAST FINCHLEY, N.2. K 886

THE BRITISH THOMSON-HOUSTON RESEARCH LABORATORY, RUGBY, require a **MECHANICAL OR ELECTRICAL ENGINEER** to assist in a programme of machining research with special reference to spark grinding and other applications of electro-erosion.—Applicants are invited to write to the DIRECTOR OF RESEARCH, BRITISH THOMSON-HOUSTON CO., LTD., RUGBY, giving details of age, qualifications and experience and quoting reference TJ. K 890

SENIOR DRAUGHTSMAN required, London area. Heavy Mechanical Engineering experience essential, knowledge of gearing an advantage.—Write, stating age and salary required and giving full details of experience, to BOX L 35, Offices of ENGINEERING.

Applications invited from
DRAUGHTSMEN OF HIGHER NATIONAL CERTIFICATE standing for interesting post with important company pleasantly situated within easy reach of Leicester. This post offers good prospects and carries Staff Status and Contributory Pension Scheme. Commencing salary, £650 per annum. Applications, which will be treated in strict confidence, should be addressed in first instance to BOX L 37, Offices of ENGINEERING.

IMPERIAL CHEMICAL INDUSTRIES LIMITED.

ALKALI DIVISION.

WINNINGTON, NORTHWICH, CHESHIRE.

STRUCTURAL AND CIVIL ENGINEERING DESIGNERS.

Vacancies exist in our Civil Engineering Department for Assistant Technical Officers to work as structural and civil engineering designers. Applicants age 25-40 should possess H.N.C. and have had experience either in structural work or in reinforced concrete and general building work.

Appointments are to the permanent Staff, five-day week, with good salaries, first class working conditions and recreational facilities. Contributory Pension Fund and Profit-Sharing Schemes. Married men can receive limited assistance with removal expenses.—Write for official application form to STAFF MANAGER quoting reference GES/STRUCT. L 216

C.A.V. LIMITED

require an

ASSISTANT DEVELOPMENT ENGINEER

on the design and development of special purpose testing equipment simulating vehicle operating conditions.

Applicants should be up to 30 years of age and must have Higher National Certificate with a sound knowledge of machines and mechanisms; a familiarity with electric or electronic equipment would be an advantage.

Salary according to qualifications and experience.

Five-day week, pensionable, good sports and social facilities.

Write stating age, qualifications and experience to:—

Personnel Manager,

C.A.V. LIMITED,

Warple Way,

Acton, W.3.

L 225

O. W. ROSKILL, of 14 Great College St. S.W.1. Industrial Consultants have an opening for a **YOUNG ENGINEER OR CHEMIST** preferably with public school and university education for training in technical market research and other consulting work. An unusual combination of scientific outlook and ability to draft well is required together with wide rather than highly specialised interest in technological matters. L 219

DESIGN DRAUGHTSMAN for design of equipment and instruments for a very comprehensive range of experiments in the research laboratories of British Insulated Callender's Cables, Limited, 38, Wood Lane, W.12. Candidates should be of Higher National Certificate or equivalent standard and should have had workshop training. Previous experience in this class of work would be desirable but it is not essential and good general mechanical experience would be acceptable. Candidates should be in the age range 25-30. The position would lead to permanency and is pensionable after a qualifying probationary period.—Write giving details of age, qualifications and experience to STAFF OFFICER, B.I.C.C. LIMITED, 21, BLOOMSBURY STREET, LONDON, W.C.1, reference L/28/56. L 208

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.

ARMAMENTS DIVISION.

MECHANICAL ENGINEERS

are required for work in connection with guided missiles. Previous design experience in mechanical handling or conveyor systems, together with some knowledge of rubber technology, would be useful, and it is desirable that applicants should possess H.N.C. or equivalent.

Pleasant working conditions and amenities are provided and an attractive superannuation scheme is in operation. The work is of a permanent character in a new and expanding field and salaries are good.

Replies will be treated in strict confidence, and should be addressed to :—

Technical Appointments Officer,
Sir W. G. Armstrong Whitworth Aircraft Ltd.,
Baginton, Nr. Coventry.

Please quote reference H/6/ARM/TAO. L 46

JIG AND TOOL DESIGNERS.

Experienced Senior men required by

THE DE HAVILLAND ENGINE COMPANY LIMITED,

for work on reciprocating and jet engines.

The work is interesting, requiring a high degree of initiative, and only experienced men with good practical training will be considered.

Excellent working conditions in modern office. Five-day week. Sports and Canteen facilities.

Written applications only, to the PERSONNEL OFFICER, THE DE HAVILLAND ENGINE COMPANY LIMITED, LEAVESDEN AERODROME, NR. WATFORD, HERTS. L 11

DRAUGHTSMAN SENIOR, required by firm of Consulting Engineers. Heavy structural steelwork and platework. High salary and bonus. Comfortable working conditions and subsidised meals on premises. Five-day week. South London area. Write stating age, experience and salary required to BOX L 177, Offices of ENGINEERING.

A MECHANICAL ENGINEER, with Degree, or comparable qualifications is required for technical development and experimental work on Crawler Tractors and Ancillary Equipment. Able to organise testing programmes and interpret design problems under the supervision of the Chief Engineer. Experience with Diesel Engines, Transmission, and Earth Moving Equipment an advantage. Age preferably between 30 and 40. Contributory Pension Scheme and Free Life Assurance Scheme operating. Write in first instance giving full details of qualifications, experience, age and salary required to PERSONNEL MANAGER, JOHN FOWLER & CO. (LEEDS) LTD., LEATHLEY ROAD, HUNSLET, LEEDS, 10. L 182

ASSISTANT CIVIL ENGINEER required by KENT OIL REFINERY LTD., Isle of Grain, Rochester, Kent. Applicants, age 25-35, should be in possession of A.M.I.C.E. or at least be exempt from Parts A and B of The Institute of Civil Engineers' Examination for Association Membership. Five years' practical experience of maintenance of industrial buildings and structures, roads, railways and port installations, together with ability to prepare specifications and contract documents desirable.—Write stating age, qualifications and experience to BOX EG.974 c/o 191, GRESHAM HOUSE, E.C.2. L 83

BRITISH PETROLEUM COMPANY, LIMITED, has immediate vacancies for
CHEMISTS, PHYSICISTS, CHEMICAL ENGINEERS AND MECHANICAL ENGINEERS for work in their United Kingdom Refineries and at their Research Station at Sunbury-on-Thames. Applications are invited from men with University degrees or equivalent qualifications and who have fulfilled National Service obligations. Previous Industrial experience desirable but not essential. Age preferably not above 33. Salaries within the range £650-£1300 according to qualifications and experience. Excellent working conditions. Non-contributory Pension Scheme.—Write, giving full details quoting H 3297 to BOX 8590, c/o full, GRESHAM HOUSE, E.C.2. G 565

ESTIMATORS required for large Refinery Construction Project at the Isle of Grain, Kent. Applicants must be experienced in estimating labour costs of fabrication and field erection of Mechanical Plant, Pipework, etc.—Write stating age, qualifications and experience to BOX EG.978, c/o 191, GRESHAM HOUSE, E.C.2. L 170

SENIOR DRAUGHTSMAN required by **HEATING AND VENTILATING** engineers in Westminster. Excellent prospects for experienced man. Five-day week, luncheon vouchers. Applicants should write, stating age, experience and salary required to J. B. JACKSON & PARTNERS LTD., 167/8, MILLBANK, LONDON, S.W.1. L 176

BRITISH STANDARDS INSTITUTION.

A QUALIFIED MECHANICAL ENGINEER is required as Technical Officer by the British Standards Institution. He will act as Secretary to committees dealing with mechanical engineering subjects especially in the railway field. Aptitude for committee work is essential.

The salary of the post is at present £650 to £1050; the starting salary dependent on qualifications and experience. The position is pensionable.—Apply in writing to the ESTABLISHMENT OFFICER, B.S.I., 2, PARK STREET, LONDON, W.1. L 226

SENIOR PROJECT ENGINEERS.

LOCKHEED HYDRAULIC BRAKE CO., LTD.,
LEAMINGTON SPA

Have a number of vacancies for Senior Project Engineers. Applicants should possess an Engineering degree or be eligible for membership of a recognised engineering institution and have had about 5 years' engineering experience, preferably in the automobile field. In addition they must have drive, initiative, a flair for original design, and the ability to direct the requirements of development testing. These are Senior appointments and the commencing salary will be commensurate with experience and qualifications.—Applications in strictest confidence, should give full details of qualifications, experience and positions held, with salary, to :—

PERSONNEL OFFICER,
LOCKHEED HYDRAULIC BRAKE CO., LTD.,
TACHBROOK ROAD,
LEAMINGTON SPA,
WARWICKSHIRE.

L 28

GENERAL FACTORY MANAGER.

BRYANT AND MAY LIMITED invite applications for the position of General Factory Manager of their four United Kingdom match factories. Applicants should be about 46, but a younger or older man will not be excluded. At least 10 years' experience in senior management posts in industry is essential, and applicants should have an appropriate professional qualification, though this is not essential.

The General Factory Manager will be responsible to the Board for the operation of the factories.

Commencing salary will not be less than £2500 per annum. Pension, Co-Partnership and other welfare benefits available.

The selected candidate will be required to pass a medical examination.

Applications should be addressed to the

PERSONNEL MANAGER (WORKS),
BRYANT AND MAY, LTD.,
FAIRFIELD WORKS, BOW,
LONDON, E.3.
quoting No. 103. L 127

CHIEF DESIGNER required by a well established heavy General Engineering Company with an international reputation in the manufacture of mining plant, water turbines and special engineering projects. Applicants must possess first-class academic qualifications and proven administrative ability backed by a wide practical experience of research, design and production. An appropriate salary with superannuation will be paid. Applications with full details, which will be dealt with in strict confidence should be addressed to BOX No. 131, R. ANDERSON AND CO., 14, WILLIAM IV. STREET, LONDON, W.C.2. L 118

INDUSTRIAL CONTROL DRAUGHTSMEN AND TRAINEES

Required for the design of Motor Control Gear and associated equipment. Previous experience in this class of work preferred, but not essential. Experienced Draughtsmen on electrical and/or mechanical work are invited to apply.

Draughtsmen are also required for the preparation of wiring diagrams.

Trainees, of not less than S.2, O.N.C. standard or those who are now taking S.2 will be considered for all of the above. The positions are permanent and the work offers excellent opportunities.

Pension Scheme in operation.
Full canteen facilities.
Apply for application form, quoting reference " U.4," to:—

PERSONNEL MANAGER,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
TRAFFORD PARK, MANCHESTER, 17. K 861

Classified Advertisements continued on Page 120

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.
ARMAMENTS DIVISION.

SENIOR ELECTRONIC AND ELECTRICAL ENGINEERS.

A number of Senior Engineers both Electronic and Electrical are required for work associated with the flight trials of guided weapons.

The work is of a very varied and interesting character and includes system testing and the analysis of the behaviour of complex installations including mechanical and hydraulic components, in addition to electronic and electrical components.

A number of years' experience in electronic and/or electrical engineering is essential for these positions, and service experience of radar, radio and telecommunications is a very suitable qualification.

A university degree is not essential for these positions but practical experience and experience of experimental work is highly desirable.

These positions are responsible posts and carry attractive salaries and excellent prospects.

Pleasant working conditions and amenities are provided and an attractive superannuation scheme is in operation.

All replies should be addressed to:—

TECHNICAL APPOINTMENTS OFFICER,
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.,
BAGINTON, NR. COVENTRY.

quoting reference FT/12/ARM/TAO L 47

DRAUGHTSMAN required for Engineering Dept. of Manufacturing concern. Age approx. 24-30. Educated to H.N.C. preferred. Experience in General Engineering, Plant Layout, Buildings, Factory Services, etc. Some electrical experience would be an advantage. Good man capable of working with minimum of supervision would find good conditions of employment, Canteen facilities, pension Scheme etc. Replies giving full details and salary required to MARTIN BLACK & CO. (WIRE ROPES) LTD., SPEEDWELL WORKS, COATBRIDGE. L 137

SENIOR DRAUGHTSMEN required by old-established firm of hydraulic engineers in Cheshire, preferably with design experience in hydraulic presses, valve gear and pumps. Good salary to suitable men. Five-day week, pension scheme and canteen facilities.—Apply in confidence stating age, experience and salary required to BOX L 156, Offices of ENGINEERING.

Part-time assistance required by Westminster Consultants for detailing of concrete bridges. Liberal remuneration for experienced **STRUCTURAL DRAUGHTSMAN.** Write in confidence stating age and details of experience.—BOX L 158, Offices of ENGINEERING.

DRAUGHTSMAN required by Consulting Engineers, Westminster, for reinforced concrete bridge work. Salary up to £800 per annum according to ability. Interesting work and excellent prospects. This year's holiday arrangements honoured. Write stating age and details of experience.—BOX L 159, Offices of ENGINEERING.

DRAUGHTSMEN AND STRESSMEN required for Railway Rolling Stock; knowledge of the industry preferable but not essential; applicants with knowledge of shipbuilding, aircraft, bus or light structural work would be considered.—Apply CHIEF ENGINEER, METROPOLITAN-CAMMELL CARRIAGE & WAGON COMPANY, LIMITED, SALTLEY, BIRMINGHAM. L 104

Well-known Midland aero engine company requires **MECHANICAL ENGINEERING DESIGNERS AND DRAUGHTSMEN** to join teams on various aspects of engine construction. Initial salary, £650-£1000 per annum. Owing to expansion in new drawing offices, with excellent working conditions departments will offer good prospects to men with initiative. Sickness benefits for families and pension fund. Full details quoting Reference AD/2, to BOX G 632, Offices of ENGINEERING.

ENGINEER/DRAUGHTSMAN required for Consulting Engineers office. Man with iron and steel works experience preferred, but not essential.—Write stating age, experience and salary required to JOHN MILES & PARTNERS (LONDON), LTD., 76, CANNON STREET, E.C.4. L 139

GENERAL MANAGER required for important Marine Engineering Works in North-East England. Very good prospects for the right man.—Apply BOX L 150, Offices of ENGINEERING.

DRAUGHTSMEN DESIGNERS AND DETAILERS, Senior and Junior required. Experience in Steel Bridges and Structures. Important and interesting work. Permanent positions. High salary. Five-day week. Pension scheme.—Apply stating particulars of experience to THE CLEVELAND BRIDGE AND ENGINEERING CO., LTD., 123, PALL MALL, LONDON, S.W.1. L 180

A FOREMAN, AGE BETWEEN 40/45 YEARS, is required for an old established Ingot Mould Foundry. The applicant should be fully conversant with modern production methods and in the use of sand slingers. The successful applicant would be expected to take full charge of the ingot mould section. All applications will be treated in strict confidence.—Details of age and experience to BOX L 223, Offices of ENGINEERING.

MECHANICAL ENGINEERS

THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION have several vacancies for Mechanical Engineers at Section-Leader level. Candidates should preferably have a good honours degree or equivalent in Mechanical Engineering, together with several years' experience. They will be expected to exercise leadership and initiative, and attractive salaries will be offered. All salaries are subject to annual review. There is also a pension scheme and other benefits.

SUBSTANTIAL ASSISTANCE WILL BE GIVEN WITH THE COST OF REMOVAL AND RE-HOUSING.

Apply in writing to RESEARCH DIRECTOR, PAMETRADA RESEARCH STATION, WALLSEND, NORTHUMBERLAND. L 157

DRAUGHTSMEN/DESIGNERS. Required by London Office of SHELL PETROLEUM COMPANY LIMITED. Fully experienced in one of the following categories:—(1) Structural steelwork, with some experience of R.C. structures and foundation work preferred. (2) Mechanical or general engineering. Preferably between the ages of 30 and 40. Salary according to age and experience. Pension Scheme. Canteen facilities. Social and Sports Club facilities. Please apply in writing, giving full details to STAFF DEPARTMENT (R), ST. HELEN'S COURT, GREAT ST. HELEN'S LONDON, E.C.3. L 115

EXCEPTIONAL OPPORTUNITY for **FULLY QUALIFIED GAS ENGINFER** with good distribution/utilisation experience to be groomed for senior position as **DISTRIBUTION ENGINEER** on Natural gas project in West Pakistan under management of Major British Oil Company. Excellent salary with pension scheme, free furnished married accommodation and medical attention. Only first grade men with ambition, initiative and personality need apply and preferred age is 32 to 35. Full personal details together with particulars of qualifications and experience (in duplicate if possible) should be sent to BOX EG.973, c/o 191, GRESHAM HOUSE, E.C.2. L 84

THE MILLOM & ASKAM HEMATITE IRON COMPANY LIMITED.

Applications are invited for the appointment of a **CHIEF ENGINEER** for Millom Iron Works. Salary £1500 to £2000 according to experience and qualifications (House available).

Write with full particulars of age, experience and qualifications to:—

GENERAL MANAGER,
THE MILLOM & ASKAM HEMATITE IRON CO., LTD.,
MILLOM, CUMBERLAND. L 166

Applications are invited for a **POWER AND SERVICES SUPERINTENDENT'S ASSISTANT** in a West Country steam and power raising plant. Applicants should be age 25 to 35, possess a Higher National Certificate (including good results in heat engines), and have had practical experience in coal fired boiler plant, turbine and steam services generally. An apprenticeship in turbine or boiler work would be an advantage.—Write quoting Ref. No. E52 Eg., stating full details including salary expected, to BOX L 163, Offices of ENGINEERING.

CABLE BELT LIMITED, ROSE STREET, INVERNESS.

A new and expanding company, manufacturing a new type of conveyor used primarily in the Mining Industry, require a First Class **SENIOR DRAUGHTSMAN** and a **JUNIOR DRAUGHTSMAN.** Duties will include short periodic supervision of erection. Experience in conveyors and ancillary equipment is desirable although not essential, as men with sound general engineering background will be considered. Attractive salaries will be offered to suitable applicants.—Please apply, giving full particulars, to the CHIEF ENGINEER. L 148

DESIGNER DRAUGHTSMEN required by the CHESTERFIELD TUBE COMPANY. Interesting work involving design and development of mechanical handling devices and a variety of heavy plant. Experience main qualification. Permanent position, substantial salary, good pension scheme and five-day week. Write giving details of past experience and salary required to PERSONNEL AND WELFARE DEPARTMENT. L 142

DEPUTY CHIEF INSPECTOR required for the Company's Lancashire group of factories which are engaged in the manufacture of high precision mechanical and electro-mechanical mechanisms. Total inspection strength about 600 administered by Chief Inspectors at each separate factory.

He would have overall responsibility for all inspection and would represent the factory group at meetings, conferences, etc., in association with top management. Applicants must have first-class professional inspection abilities and experience, including Government Contract procedure, plus top management outlook and approach.

Applications will be treated in strict confidence and should give full details of education, experience, positions held, together with corresponding salaries. Replies to COMPANY CHIEF INSPECTOR, BOX L 149, Offices of ENGINEERING.

MANAGEMENT TRAINEES.

Large, expanding, light engineering Company in South Midlands is prepared to engage selected number of Young Men (23-30) for training through technical work, foremanship and on eventually to Managerial posts. Qualifications required:—

(i) Secondary Grammar School Education.
(ii) H.N.C. standard in Mechanical Engineering.
(iii) Five-year apprenticeship in reputable engineering firm or equivalent experience.

Applicants must be prepared for factory hours during training (including night shift if necessary) and to work hard for a number of years to fit themselves for the higher posts in engineering industry.—Apply in own writing, giving age, qualifications, present salary and career to date in chronological order.—BOX L 143, Offices of ENGINEERING.

CONCRETE LIMITED, manufacturers of Bison concrete floors and concrete frames, the leaders in this trade, require a **SALES MANAGER** for the Midlands Area, based on Birmingham. He will be a salesman with responsibility for co-ordinating sub-area representatives' work.

The salary is £2000 p.a., and with commission will total about £3000 p.a.; a non-contributory Life Assurance and Pension Scheme substantially increases the value of the emoluments. Applications are invited only from men of good education, social background, good health, initiative and energy, preferably with good professional qualifications and an intimate knowledge of Architectural and Engineering practice in the area, or who have extensive executive-level selling experience.

Applications will be dealt with by a director only and treated in confidence; they should give details of education, training, age, experience, present work and social background. State if interview preferred in London or Birmingham. Mark the envelope "S.M." in top left hand corner and address to CONCRETE LIMITED, 16, NORTHUMBERLAND AVENUE, LONDON, W.C.2. L 100

DRAUGHTSMAN AGED 23/30 with general engineering background required. 40 hr. Five-day week. Write stating age, experience, certificates held, and salary required to SECRETARY, MERRYWEATHER & SONS, LIMITED, GREENWICH HIGH ROAD, LONDON, S.E.10. L 174

DRAUGHTSMEN
and
DESIGNERS

Applications are invited for the following positions on the regular Mechanical Engineering drawing office staff of a large iron and steel organisation:—

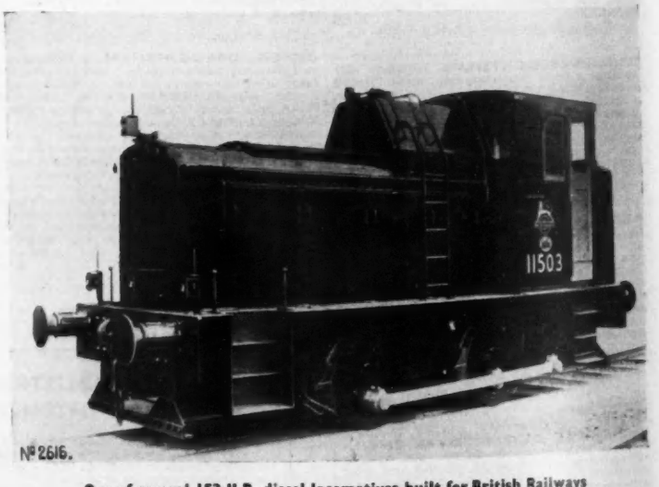
1. **DESIGNER,** fully experienced and accustomed to medium and heavy engineering equipment.
2. **SENIOR DRAUGHTSMAN,** with similar experience to the above.

There are also openings for draughtsmen of lesser seniority who have completed their National Service and have, including engineering training, not less than 5 years drawing office experience.

Nominal hours are 38 per week with payment for overtime to draughtsmen grades. A contributory superannuation fund is in operation.

Apply giving full particulars of engineering experience and training, also technical education and qualifications, stating salary required and when at liberty to BOX K 895, Offices of ENGINEERING.

BARCLAY
LOCOMOTIVES
DIESEL • STEAM • FIRELESS
(Coal or oil fired)



One of several 153 H.P. diesel locomotives built for British Railways

Andrew Barclay Sons & Co. Ltd.

CALEDONIA WORKS KILMARNOCK
Telegrams: "BARCLAYSON KILMARNOCK" Telephone: Kilmarnock 1366/7

LONDON OFFICE: 38 VICTORIA STREET, WESTMINSTER
Telegrams: PLATCO, SOWEST, LONDON Telephone: ABBey 6407

CHIEF MECHANICAL ENGINEER.

LEVER BROTHERS, PORT SUNLIGHT, LIMITED, invite applications for the position of Chief Mechanical Engineer at their Port Sunlight factory. Applicants must be under 45 years of age and have a University degree or an appropriate professional qualification.

The Chief Mechanical Engineer is responsible, under the Chief Engineer, for all mechanical aspects of plant maintenance, new construction work, and machine development of an extensive factory, the operations of which include soap and detergent manufacture and automatic packing; glycerine recovery and distillation; printing and carton manufacture; transportation including motor vehicles, locomotives, barges and dock installations.

Applicants must be capable of directing and co-ordinating a large and widely distributed department with a total personnel of over 500, including management and technical staff Commencing salary will be not less than £2000 per annum.

The selected candidate will be required to pass a medical examination and to contribute to the Company's Superannuation Fund. Applications should be addressed to:

THE PERSONNEL DIRECTOR,
LEVER BROTHERS, PORT SUNLIGHT, LIMITED,
PORT SUNLIGHT,
CHESHIRE,

and marked "Chief Mechanical Engineer." L 153

WORKS MANAGER
required by long established
and well known Company
on EAST COAST OF SCOTLAND,
manufacturing medium and heavy engineering
products of world wide renown.

Only applicants now holding a similar position, having proven experience of modern machine shop practice, up-to-date production methods and qualified to direct shop supervision and accustomed to collaborate with organised planning and rate-fixing etc., are invited to apply in strict confidence.

Applicants should set out clearly full particulars of education, training, experience and positions held with dates and responsibilities covered.

The position advertised has been notified to the Company's senior personnel and is one that carries a good salary and pension.—Write BOX EG.942, c/o 191, GRESHAM HOUSE, E.C.2. L 145

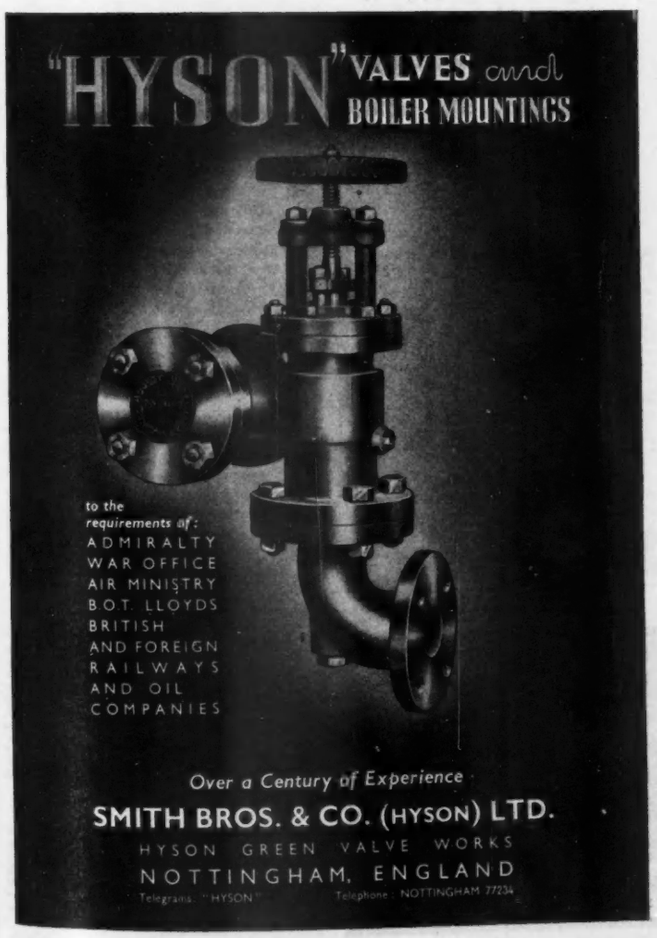
DEVELOPMENT ENGINEERS AND PHYSICISTS

are required for work in the new and rapidly expanding laboratories of LOUIS NEWMARK, LTD., at New Addington, Surrey. The work includes the design and development of instruments and equipment for the aircraft and allied industries, and some working experience of small electromagnetic instruments is desirable. A degree or similar qualification essential. Good salary based on age and experience. Contributory Pension Scheme.—Apply in writing giving full particulars to: PERSONNEL OFFICER, LOUIS NEWMARK, LTD., PREFECT WORKS, PURLEY WAY, CROYDON. L 165

DRAUGHTSMAN required for detail work in connection with the design of equipment and instruments for a comprehensive range of experiments in the research laboratories of British Insulated Callender's Cables Limited, 38, Wood Lane, W.12. Candidates should be in the age range 25-30. The position would lead to permanency and is pensionable after qualifying probationary period. Applications giving details of age, qualifications and experience to STAFF OFFICER, B.I.C.C. LIMITED, 21, BLOOMSBURY STREET, LONDON, W.C.1, reference L/29/56. L 207

A MAINTENANCE ENGINEER is required by a large organization in the Home Counties engaged in the heavy processing industry. The selected candidate will be responsible for controlling a maintenance force of about 250 and consequently a thoroughly qualified and experienced man is required. Starting salary is in the region of £1,500 per annum with good prospects of advancement. Please send applications with tabulated details of age, education and experience in confidence to BOX L 168, Offices of ENGINEERING.

DRAUGHTSMEN ON MECHANICAL/ELECTRICAL SIDE for Westminster consultants. Age range 20/25 approximately. Extensive experience not essential but H.N.C. studies most helpful. Salary will be based on both experience and technical education. Full details of studies and employment to BOX L 181, Offices of ENGINEERING.



CANADA

A British Company of world-wide repute engaged in the manufacture of gear producing machines, equipment and tools requires, for the Canadian Company,

A GEAR FOREMAN

to take charge of the production of all types of gears and with a knowledge of estimating and calculation. Applicants should give full details of past experience, domestic commitments, etc. The selected candidate will be required to enter into an agreement for a period of employment and the Company will provide facilities for emigrating, including fares and out of pocket expenses.—Write BOX L 186, Offices of ENGINEERING.

METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,

have the following vacancies in their Research Department :—

HONOURS GRADUATES IN ENGINEERING OR PHYSICS

with post-graduate or industrial research experience to work on—Heat Transfer, with particular reference to industrial nuclear energy, Wear and Lubrication.

The work is of considerable scientific interest and successful applicants of suitable ability would be encouraged to form and lead their own experimental teams. The posts provide excellent opportunities for men with originality and an aptitude for experimental work to establish themselves in these important branches of applied research. Age limits 24-35 years.

Vacancies also exist for younger men interested in original experimental work in these and other fields which include :—

Experimental Stress Analysis.
Failure of Metals under Compound Stress.
Physics of Metal Surfaces.
Metal Cutting Research.

For these vacancies previous research experience, though desirable, is not essential.

MECHANICAL ENGINEERS.

Ordinary degree, H.N.C., or similar qualifications for experimental work and the development of experimental equipment in the Mechanical, Thermodynamics and Metal Cutting Laboratories. Candidates must have had practical workshop experience. Some knowledge of experimental work would be an advantage. Age limits, 25-30 years.

MECHANICAL ENGINEER OR METALLURGIST,

preferably graduate, to organise the preparation and periodical review of data sheets on the mechanical properties of engineering materials. The work would involve maintaining a running survey of available mechanical test data (including creep and fatigue) both from published sources and from the Company's own mechanical testing laboratories, and might include some experimental work. Research experience is not essential, but a knowledge of mechanical testing and the application of test data to engineering design would be an advantage.

TECHNICAL ASSISTANTS,

O.N.C. (Mechanical), or similar standard, for general duties in the mechanical testing laboratories. Practical workshop experience is essential and some laboratory experience would be an advantage. Preference would be given to applicants intending to study for higher technical qualifications. Age limits, 23-30 years.

These posts are permanent and pensionable, and in all cases salary would be in accordance with age, qualifications and experience.

Apply for Application Form, quoting reference "W.4," to :—

PERSONNEL MANAGER,
METROPOLITAN-VICKERS
ELECTRICAL CO., LTD.,
TRAFFORD PARK,
MANCHESTER 17. L 201

A very successful and expanding small public company, turnover about £1m., manufacturing compounds and mastics, requires a

MAN AGED 35 TO 45 TO TAKE CHARGE OF WORKS AND LABORATORY. Must have degree or equivalent and be experienced in administration and technical aspects of chemical engineering Initial salary £3500 to £4000, with prospects of directorship within 12 months. This appointment offers unlimited scope to a man with the right experience and strong personality.

Reply in confidence, giving full history in chronological order, to PRODUCTION-ENGINEERING, LTD., 12, GROSVENOR PLACE, LONDON, S.W.1, who are acting as consultants. L 106

CHIEF ENGINEER with prospects of advancement to Works Director—Age 35-50, required by London Company manufacturing medium heavy precision machinery. A qualified man with experience at all levels—capable of directing and supervising Design and Production. Organising ability essential. A salary commensurate with the qualifications required and responsibility of the job will be paid. State age, experience and present salary to SOAG MACHINE TOOLS, LTD., JUXON STREET, LAMBETH, S.E.11. L 107

ASSISTANT TO CHIEF ENGINEER required by small progressive Engineering Firm in South Wales, age 25-28, must have D.O. experience and hold O.N.C. experience in conveyors and mechanical handling equipment an advantage.—Apply BOX L 175, Offices of ENGINEERING.

CHIEF RESEARCH OFFICER required for the recently formed Heating and Ventilating Research Council at their new laboratories in Leatherhead. This Council receives support from the Department of Scientific and Industrial Research. The successful applicant will be required to carry out and supervise research work on various heating and ventilating problems and collate data for use of the industries concerned. The ability to initiate and carry out research is essential, and experience of the heating and ventilating industry is desirable. Applicants should send details of their research and other experience, stating salary required, to:—THE SECRETARY, c/o MESSRS. ANDREW W. BARR & CO., 202, BISHOPSGATE, LONDON, E.C.2. L 108

WEAPONS RESEARCH DIVISION
A. V. ROE AND CO. LTD.
AN INSTALLATION ENGINEER

is required for design work connected with the ground and air launching of guided missiles. This is a Senior Staff position carrying a good salary and prospects of advancement in an expanding organisation.

The company has a pension and life assurance scheme, and the Division is situated in pleasant surroundings, with convenient access to Stockport and Manchester.

Applicants should possess H.N.C. or equivalent, and several years' design experience. Experience of Armament installations would be an advantage.

Applications to :

THE CHIEF ENGINEER,
WEAPONS RESEARCH DIVISION,
A. V. ROE AND CO. LTD.,
WOODFORD, CHESHIRE.

K 990

STRUCTURAL ENGINEER required by London firm of Consultants to take charge of their steel design office. Candidates must have a comprehensive knowledge of all types of structural steelwork both designing and detailing and should preferably have had some works experience. Applicants should be Corporate Members of one of the senior professional Institutions or hold similar Degrees. The post is a permanent one and there is a Staff Pension Scheme.—Please reply in confidence to BOX NO. 389, GLOVERS ADVERTISING, LTD., 351, OXFORD STREET, W.1. G 649

NEW RESEARCH LABORATORY
IMPORTANT APPOINTMENTS

Powers-Samas Accounting Machines, Ltd. (one of the Vickers Group of Companies) is expanding the resources of its Research Division for the development of electronic data processing equipment, punched-card machines and allied devices. A new Research Laboratory is under construction at Caterham, Surrey—and until its completion the staff appointed will work at existing establishments in Croydon and Crayford, Kent.

The appointments offered provide scope for both senior and junior staff. Salaries will be competitive and in accordance with qualifications and experience. Applications are invited from:—

1. Honours graduates in physics or engineering for a wide range of research and development work on electronic computors and associated equipment.
2. Engineers with Higher National Certificate for development and design work on electronic computors and associated equipment.
3. Juniors possessing evidence of the necessary scholastic and technical ability who wish to continue with studies for higher qualifications.

Applications, with details of previous experience and qualifications, should be sent to THE PERSONNEL MANAGER, POWERS-SAMAS ACCOUNTING MACHINES, LTD., CROYDON. G 628

Classified Advertisements continued on Page 123

INDUSTRIAL CONTROL
(Servo Development.)

GRADUATE ENGINEER required for development work on magnetic and electronic amplifiers for servo systems in Industrial Control Applications, including Mining and Heavy Industry.

Applicants should have completed their National Service and have had experience of servo techniques and magnetic amplifiers.

The post is permanent and pensionable.

Apply for application form, quoting reference "8.4," to:—

Personnel Manager,
METROPOLITAN-VICKERS ELECTRICAL CO., LTD.,
Trafford Park, Manchester 17 L 44

TWO ENGINEERING DRAUGHTSMEN required by AVON INDIA RUBBER CO., LTD., MELKSHAM, WILTS, for mechanical equipment design work. Interesting and progressive situations offered to suitable applicants. H.N.C. standard or equivalent, but others with the necessary experience may apply to the CHIEF ENGINEER, with full particulars of age, etc. K 920B

DRAUGHTSMAN required for Engineering Department of modern Tar Distillery. Applicants should be of at least O.N.C. Standard with General Engineering experience, preferably including plant layout and piping. Varied and interesting work, including some site work. Pension scheme. Salary up to £750 per year.—Apply to CHIEF ENGINEER, LANCASHIRE TAR DISTILLERS LIMITED, LIVERPOOL ROAD, CADISHEAD, NR. MANCHESTER. L 36

DIESEL ENGINE TEST ENGINEER required by NORTH BRITISH LOCOMOTIVE CO., LTD., DIESEL ENGINE DIVISION, for new appointment with good opportunities. Superannuation scheme, five-day week.—Apply in writing stating experience, age, etc., to (IG), PERSONNEL MANAGER, SPRINGBURN, GLASGOW, N.1. L 22

A.E.C. LIMITED require
DETAIL DRAUGHTSMEN. Experience of the motor industry an advantage. Modern offices and equipment, excellent opportunities for progress. Good salary offered, five-day week, pension scheme and canteen facilities.—Applications in writing, giving age, experience and salary required to STAFF RECORDS OFFICER, WINDMILL LANE, SOUTHALL, MIDDLESEX. K 877

DRAUGHTSMAN DESIGNERS required for UNILEVER LTD., LONDON OFFICE. Workshop trained. At least O.N.C. standard for design and planned layout of factory plant. Candidates should have experience in general mechanical engineering. Pension Scheme and canteen.—Send particulars of age, training and experience in full to: PERSONNEL DIVISION (WAD 114), UNILEVER LTD., UNILEVER HOUSE, LONDON, E.C.4. L 3

RESEARCH ENGINEER OR PHYSICIST

with advanced knowledge of thermodynamics required by a Glasgow Engineering Company. Applicants, aged 25-30, should have a University Honours Degree. Experience in heat transfer problems would be an advantage. Salary depending on qualifications and experience.—Apply to BOX G 583, Offices of ENGINEERING.

DRAUGHTSMEN required for detail work on printing machinery. Good opportunity for young men to specialise. Excellent conditions, pension scheme, canteen. Please send brief particulars to H.T.E. LTD., BLACKHORSE LANE, WALTHAMSTOW, E.17. L 24

TWO MOULD DRAUGHTSMEN required by AVON INDIA RUBBER CO., LTD., MELKSHAM, WILTS. The work entails making working drawings of a wide variety of moulds covering tyres and general rubber goods manufacture. Good opportunity for suitable applicants to establish themselves in permanent situations.—Apply to the CHIEF ENGINEER, with full particulars, age, etc. K 920C

DESIGN ENGINEER for GAS TURBINE Drawing Office, for thermo dynamic and mechanical design calculations, etc. Applicants with degree preferable, but not essential. Candidates must be corporate members of the Institution of Mechanical Engineers, with sound technical background and some experience in Industrial Gas Turbines, Steam Turbines or Aero Engines, etc. Salary according to age and qualifications.—Application forms can be obtained from the EMPLOYMENT MANAGER, RUSTON & HORNSBY LIMITED, LINCOLN. L 31

JOSEPH LUCAS (ELECTRICAL) LIMITED intend to appoint a **DEPUTY CHIEF METALLURGIST** with a view to his subsequent promotion to Chief Metallurgist in charge of a staff of about forty. The applicant should, preferably, have an honours degree in metallurgy and be between the ages of 35 and 45. Experience in the field of light engineering is essential, and in quantity production a distinct advantage. He will be responsible for, and with the aid of specialists be expected to deal with the specification and testing of, incoming materials; production heat treatment, which includes heating in controlled atmosphere furnaces and by induction, carburising by the solid, liquid and gaseous methods, and nitriding; with welding, brazing and soldering, and with pyrometric control. He must have a knowledge of most kinds of cold-forming and machining processes. He will be required to advise metallurgically those who are responsible for engineering design, and to collaborate with those who have to maintain an unusually high level of quantity production. Special notice will be taken of an ability to write clear reports.—Apply to the PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL) LTD., GREAT KING STREET, BIRMINGHAM, 19, quoting reference PM/D/128. K 986

DRAUGHTSMAN required for Engine Design Schemes on small high-speed diesels must have initiative and experience. Good salary. Pleasant working conditions. Pension Scheme.—Apply CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES. G 650

WORK STUDY.
MAN WITH UNIVERSITY DEGREE OR THE EQUIVALENT and some industrial experience wanted to organise work study. Specialised training in work study, particularly the methods side, will be given. The post is an interesting one and offers excellent opportunities for training and development of a new section. Contributory pension scheme.—Apply, stating age, experience and training, to PERSONNEL MANAGER, FERODO LIMITED, CHAPEL-EN-LE-FRITH, VIA. STOCKPORT. L 126

DETAIL DRAUGHTSMEN required. Men experienced in Industrial Furnace, Gas Plant or similar work preferred. Write giving full particulars and salary required to CHIEF DRAUGHTSMAN, FURNACE DEPARTMENT, THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LIMITED, PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1. L 125

ASSISTANT DEVELOPMENT ENGINEER required by important company within easy reach of Leicester. Higher National Certificate in Mechanical Engineering essential and applicants should have had Works and Drawing Office experience. Age 23-26. Applications marked Private and Confidential should be addressed in first instance to The Personnel Manager, BOX L 122, Offices of ENGINEERING.

Required by Consulting Engineers:

(A) CHIEF RESIDENT ENGINEER for overall supervision of very extensive works to be constructed in British West Africa, including railways, roads, tunnels, bridges, power houses, conveyors, jetties, water supply, housing, hospital, etc.

This very responsible appointment, lasting several years, requires a fully qualified Civil Engineer with an exceptional degree of experience professionally as well as in responsible administration of engineering contracts.

(B) RESIDENT ENGINEER.
Fully qualified Civil Engineer required to act as deputy to Chief Resident Engineer for constructional works as above. Wide experience required, with good knowledge of administration of contracts.

(C) QUANTITY SURVEYOR.
Required to be a corporate member of the Royal Institute of Chartered Surveyors and to be responsible to the Chief Resident Engineer for all measurement, payment and other contract questions on the constructional works as above.

Replies, with full details of qualifications and experience, which will be treated in the utmost confidence, should be addressed "T." LIVESEY AND HENDERSON, NATIONAL HOUSE, 12-18, MOORGATE, LONDON, E.C.2. L 117

GEORGE WIMPEY & COMPANY LIMITED,

are engaged in the design and construction of Refineries, Chemical Works, heavy industrial installations and all classes of heavy mechanical engineering. The following vacancies are offered to experienced men :—

CHIEF MECHANICAL DESIGN ENGINEER

to take charge of the large, rapidly expanding Drawing Office in London. The initial salary will be up to £2000 p.a. (or more for exceptional qualifications).

SITE PROJECT MANAGERS

and Assistants, who will receive substantial salaries and subsistence allowances.

MECHANICAL DESIGN ENGINEERS MECHANICAL JOB ENGINEERS

Ability and experience in this field are more important than formal qualifications though A.M.I.Mech.E. or H.N.C. will be preferred. Job Engineers should have a knowledge of Process Piping Tankage, Pumps and General utilities arrangements and layouts.

Initial salary range: Senior, £1200-£1500; Intermediate, £900-£1200; Junior, £650-£900.

ESTIMATING AND SCHEDULE ENGINEERS

Experience is essential in preparing estimates for construction and the compilation of progress reports and construction schedules.

Initial salary range: Senior, £750-£1000; Junior, £500-£750.

Five-day week. Pension Fund after preliminary period of satisfactory service. Salary reviewed every half-year.

Write, giving full details, to GEORGE WIMPEY AND CO., LTD., 27, HAMMERSMITH GROVE, LONDON, W.6, quoting Ref. R/30B. L 13

THE ASSOCIATED ETHYL COMPANY LIMITED has vacancies for the following at its Engine Laboratory, Bletchley.

YOUNG GRADUATE IN MECHANICAL ENGINEERING to assist in experimental programmes on vehicles in connection with the use of gasoline and lubricants. Experience in this field is not essential, but applicants must have completed their National Service and preferably should not be above 26 years of age.

TECHNICAL ASSISTANT FOR ENGINE INSTRUMENT SECTION. Applicants should have (*a*) sound working knowledge of contemporary electronic test equipment, (*b*) ability to construct and calibrate special thermocouples and (*c*) ability to develop new types of instruments. Experience of application of instruments to engine and vehicle testing an advantage. Preference given to candidates holding H.N.C. or City and Guilds equivalent in electrical and electronic subjects.

The successful applicants will be invited to join the Company's Contributory Pension Scheme.

Attached to the Engine Laboratory is a Cafeteria where subsidised lunches are served.

The selected applicants will be eligible for recommendation to the local council in respect of housing.

Applications, giving brief particulars of age, education, qualifications and experience should be sent to:—THE OFFICE CONTROLLER, THE ASSOCIATED ETHYL COMPANY LIMITED, ENGINE LABORATORY, WATLING STREET, BLETCHLEY, BUCKS. L 217

A MECHANICAL ENGINEER is required by the WESTINGHOUSE BRAKE & SIGNAL CO. for work in connection with design, development and testing of mechanical, pneumatic and electro-mechanical equipment for Railway Signalling. Applicants are not expected to have had experience of this particular type of work, but some experience of design of mechanical equipment is desirable. The minimum qualification is H.N.C. in mechanical engineering. Salary will be in accordance with age, qualifications and experience. The Company operates a Pension Scheme, and a 5-day week. Write giving details of age, qualifications and experience, to PERSONNEL SUPERINTENDENT, WESTINGHOUSE BRAKE & SIGNAL CO., LTD., CHIPPENHAM, WILTS, quoting reference No. EQUIP/N/O. L 121

PLANT ENGINEER 25-35 YEARS, required for progressive Company of Engineers and Founders. Group Pension Scheme and Employees Share Holding Scheme operated. Applications in writing to KENT ALLOYS LIMITED, TEMPLE MANOR WORKS, ROCHESTER, KENT. L 124

The following appointments are available in

THE ATOMIC ENERGY DEPARTMENT

of

THE GENERAL ELECTRIC COMPANY LIMITED

at Erith, Kent

for development and Design work on

NUCLEAR POWER STATIONS

Ref. A.E.D.1
MECHANICAL ENGINEERS with experience in the design and layout of large steam Power Stations. Applicants should have a degree in Engineering and not less than five years experience in this type of work.

Ref. A.E.D.2
A MECHANICAL ENGINEER with a first or second class honours degree who has specialised in stress analysis problems in complex steel structures.

Ref. A.E.D.3
MECHANICAL ENGINEERS, preferably with honours degrees, who have had experience in heat transfer research and heat exchanger design.

Ref. A.E.D.4
A MECHANICAL ENGINEER, preferably with a degree and with experience in the development of prototype mechanisms, to take charge of a laboratory where reactor control and fuel element handling equipment is now being tested.

Ref. A.E.D.5
DESIGNER-DRAUGHTSMEN with experience in Power Station layout, heat exchanger and pressure vessel design, and the design of mechanical control equipment and servo mechanisms.

Attractive salaries will be offered and the positions available afford excellent opportunities for advancement.—Apply giving age and details of training and experience to PERSONNEL MANAGER, THE GENERAL ELECTRIC CO., LTD., FRASER & CHALMERS ENGINEERING WORKS, ERITH, KENT. K 606

SUPERINTENDENT ENGINEER

required for service in NIGERIA by old-established British concern to supervise and control an expanding group of factories processing a primary product, with the attendant European and African engineering staff.

Good all round practical mechanical engineering knowledge is essential with particular experience of medium range diesel engines and hydraulics. Experience of the erection of light structural steelwork and foundations an advantage.

Fully furnished and equipped housing. Contributory pension scheme providing for retirement from age 55. First class passages provided. Tours of 20 months, followed by 4 months leave on full pay.

SALARY by arrangement and will be substantial.

Age range preferred 40 to 45.

Applicants will be interviewed in U.K. at convenient times.

In first instance apply in full confidence to BOX L 171, Offices of ENGINEERING.

MANAGER wanted to take complete charge of medium sized marine engineering works, Clyde area, engaged in specialised contracts. Steam engine experience essential. Some diesel and electrical experience an advantage. Knowledge of lifting machinery design also advantageous. Post offers good remuneration and excellent prospects. Only men with some managerial experience and having first-class organising ability will be considered.—Write stating age and giving full particulars of record and experience to 0441 WM. PORTEOUS AND CO., GLASGOW. L 133

SENIOR ENGINEER required by established firm of Engineering Contractors to be responsible for design of Industrial Finishing Plant such as mechanical painting and drying equipment for the motor and allied industries. Salary £1200 to £1500 p.a. depending on qualifications and experience.—Reply in confidence to BOX L 120, Offices of ENGINEERING.

OILFIELD PRODUCTION ENGINEER required by large Oil Company for service in Middle East. Must have University Degree with sound practical engineering experience preferably on crude oil installations. Bachelor preferred, age limit 35. Pensionable emoluments not less than £1000 (incremental), plus generous allowances. Paid home leave.—Reply in detail quoting No. 557, to BOX No. 9861, c/o CHARLES BARKER AND SONS, LTD., 31, BUDGE ROW, LONDON, E.C.4. L 119

BRITISH ENGINE BOILER & ELECTRICAL INSURANCE CO., LTD., 24, FENNEL STREET, MANCHESTER, 4.

The Company requires additional **INSPECTORS OF BOILER AND ENGINE PLANT** in a few districts. Permanent positions carrying progressive salary scale £675 to £1000 and non-contributory pension. Candidates, age not exceeding 32 years, having steam boiler and engine experience and possessing at least 1st class M.O.T. Certificate are invited to apply in own handwriting stating age, qualifications and experience. L 123

TOP FLIGHT MAN
required as
CHIEF ENGINEER
for Continental Cylinder Works. Capable of modernising plant with existing machinery. Must be good organiser and experienced in rationalization. Works' own foundry, machine shop and drop forge. Interviews London.—Write BOX L 161, Offices of ENGINEERING.

COWANS, SHELDON & CO., LTD., CARLISLE, CRANE MANUFACTURERS AND ENGINEERS, require a **CHIEF ENGINEER,** age under 40. To organise, direct and control drawing office, and be responsible for design and development of Company's products. Applicants must hold a University degree and should preferably have about 10 years' industrial experience. Post requires administrative ability and an alert progressive outlook. Salary £2000, and an endowment type pension scheme is available.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), ALMACK HOUSE, 26, KING STREET, LONDON, S.W.1, quoting C 282/6A. L 70

SITUATIONS WANTED.

QUALIFIED STEAM AND COMBUSTION ENGINEER, M.INST.F., A.M.I.M.E. Now holding executive post of Managerial status, desires appointment as manager or senior representative of British company in New Zealand, where he intends to settle. BOX L 53, Offices of ENGINEERING.

SALES ENGINEER, B.SC., G.I.MECH.E., 27, returning to England on 27th April, after two years in South Africa, requires permanent position in Central London or East Coast Area.—BOX L 147, Offices of ENGINEERING.

AGENCIES.

ENGINEERING AGENTS wide experience and excellent connections, are prepared to follow up quotation in the South Wales area.—BOX G 551, Offices of ENGINEERING.

WANTED.

STEEL, ALUMINIUM, BRASS, SHEETS AND OFFCUTS, 10 to 24 G. Small or Large quantities. Cash payment.—DYAS & FOWLE, 41, Loudoun Road, N.W.8. MAI. 2711, 5477. G 577

WANTED.

WE ARE BUYERS of all types of new ball and roller bearings in large quantities.—C.S.M., 39, AVENUE DE GENERAL LECLERC-LA GARENNE (SEINE), FRANCE. Telephone: CHA. 45-66. G 606

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STEEL TANK 16 FT. BY 10 FT. BY 4 FT. 6 IN.; ⅜ IN. thick. State price and condition and where seen.—BOX L 93, Offices of ENGINEERING.

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STEEL CHANNELS.

5 in. by 2½ in. by 10.22 lbs. per ft.
6 in. by 3 in. by 12.41 lbs. per ft.
7 in. by 3 in. by 14.22 lbs. per ft.
7 in. by 3½ in. by 18.28 lbs. per ft.
8 in. by 3 in. by 15.96 lbs. per ft.

STEEL PLATE.

10 ft. 0 in. by 5 ft. 0 in. by ½ in. plate.
10 ft. 0 in. by 5 ft. 0 in. by ⅝ in. plate.
10 ft. 0 in. by 5 ft. 0 in. by ¾ in. plate.
Please quote quantities and prices in the first instance to BOX G 1, Offices of ENGINEERING.

WANTED.

DISCARDED UNGALVANISED STEEL WIRE ROPE. Large quantities 4⅜ in. to 5¾ in. circumference in 6/19, 6/24 or 6/37 normal construction and preferably in 100/110 tons tensile, but would consider other tensiles. Please send prices and lengths.—APPLEBY-FRODINGHAM STEEL CO., BRANCH OF THE UNITED STEEL CO's. LTD., SCUNTHORPE, LINCS.
Telephone No.: Scunthorpe 3411. L 162

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"DRAWINGS WITH TENDER?" Why not. Isometric Lay Out giving comprehensive illustration of exact proposals.—Apply BOX K 429, Offices of ENGINEERING.

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GENERAL ENGINEERS,
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HAMMERSMITH, W.6.
'PHONE: RIV. 4416.

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&
PROFILE CUTTING.

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DESIGN AND DETAIL DRAWING OFFICE WORK
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HOU. 7081/2 and 7832. L 25

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ACCURATE SCALE MODELS.
Industrial Plant, Ships, Machinery, Civil Engineering, etc.
Static or working models for exhibition, advertising or instructional purposes. Enquiries invited and estimates submitted.
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BUSINESS PREMISES.

POOLE, DORSET.
INDUSTRIAL DEVELOPMENT.
For full details of Industrial premises and factory sites available, apply REBBECK BROS., THE SQUARE, BOURNEMOUTH. (Tel. 5091/4.) L 202

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PENSOTTI 5ft. Motor Driven High Speed VERTICAL BORING MILLS
with taper turning and screw cutting attachment. Max. swing 62 in. dia. Rapid power traverses. 16 speeds from 4 to 145 r.p.m. Motor 28 h.p. Approx. weight 10 tons. 1951-2 machines in excellent condition.
F. J. EDWARDS LTD.,
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EUSton 4681 G 610

B.C.S.

15,000 BABCOCK & WILCOX C.T.M. TYPE WATER TUBE, 180 lb. with Superheater, Economiser by Green. All mountings.
TWO—14,000 JOHN THOMPSON 4 DRUM WATER TUBE, 250 lb. with Senior Economiser. All mountings.
30 FT. BY 6 FT. 6 IN. LANCASHIRE BY YATES & THOM, 160 lb. All mountings.
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Tel.: CARDIFF 29246. K 913

B.C.S.

TWO 16/20 H.P. RUSTON-HORNSBY DIESEL LOCOMOTIVES, 24 in. gauge in first-class condition.
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B.C.S.

ONE—400 K.W. SULZER DIESEL GENERATING SET, 220/440 volts, D.C. complete with Auxiliaries, Spares, etc.
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ONE—80 K.W. GENERAL MOTORS/HOUCHIN DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 1500 r.p.m., complete with all Auxiliaries and Switchboard.
ONE—55 K.W. McLAREN/BRUSH DIESEL ALTERNATOR SET, 400/440 volts, 3 phase, 50 cycles, 1000 r.p.m., complete with Auxiliaries and Switchboard.
ONE—40 K.W. SENTINEL/LEROY DIESEL ALTERNATOR SET, 400/230 volts, 3 phase, 50 cycles, 1500 r.p.m., complete with Auxiliaries and Spare Parts. New 1951.
TWO—20 K.W. HILL & CO./DELCO DIESEL GENERATING SETS, 120 volt D.C., 1450 r.p.m., complete with Auxiliaries.
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SERVICE EDWARDS VALUE!

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GACK OPEN ENDED OVERCRANK GUILLOTINE. On stand. Motorised 380/3/50. Automatic hold-down. Capacity 16¼ in. by 14 s.w.g. Gap depth 3 in. Weight about 12½ cwts.
NEW BESCO UNIVERSAL SWING BEAM BOX FORMING AND FOLDING MACHINE, Type F. Capacity 40 in. by 11 gauge. Max. lift of beam 6 in.
NEW BESCO ALL-STEEL HAND LEVER RATCHET ACTION SECTION CROPPING MACHINE, Model FEC. Portable Crops: Flat bars up to 3½ in. by ⅝ in., rounds 1⅛ in. dia., squares 1⅛ in., angles 4 in. by 4 in. by ⅝ in., tees 3½ in. by 3½ in. by ⅝ in.
RHODES GEARED BENDING ROLLER. Pinch roll type. Capacity 49½ in. by 16 s.w.g. Dia. of rolls 3 in.
Photographs of the above are available.
MACHINE TOOLS, NEW AND USED, Of Every Description. Attractive Prices.
F. J. EDWARDS LTD.,
359-361, EUSTON ROAD, LONDON, N.W.1.
Telephone: EUSton 4681-3771.
and at
LANSDOWNE HOUSE, 41, WATER STREET, BIRMINGHAM, 3.
Telephone: Central 7606-7. G 552

B.C.S.

500 H.P. UNUSED DOUBLE DRUM HAULAGE by Uskside Engineering Company (motor not included); rope speed 8 m.p.h. Each drum will hold 3300 yards of 1 in. rope. Complete, mounted on steel base frame work.
3, CASTLE STREET, CARDIFF.
Tel.: CARDIFF 29246. K 915

Classified Advertisements continued on Page **124**

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Specialists in Fabrication of Industrial Plant

IN MILD STEEL, STAINLESS, MONEL
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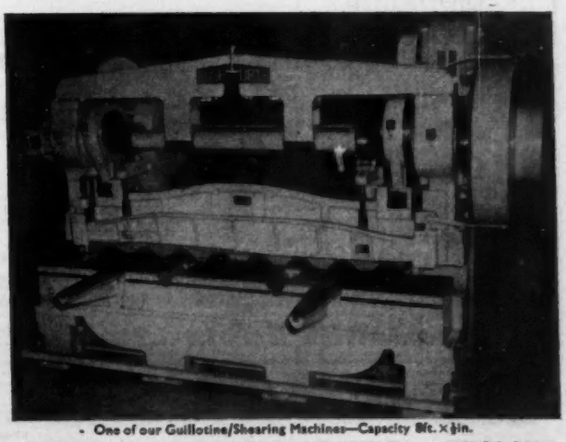
We can handle capacities up to **20 tons**

*Plate Bending & Rolling—***8ft. x 1in.** *thick*



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PATENTS.

It is desired to secure the full commercial development in the United Kingdom of **BRITISH PATENT NO. 695092** which relates to "PROCESS AND APPARATUS FOR REMOVING THE SUPERFLUOUS PARTS FROM STEEL INGOTS," either by way of the grant of licences or otherwise on terms acceptable to the Patentee. Interested parties desiring copies of the patent specifications should apply to STEVENS, LANGNER, PARRY & ROLLINSON, 5 to 9, QUALITY COURT, CHANCERY LANE, LONDON, W.C.2. L 75

NOTICE is hereby given that Armour Research Foundation of Illinois Institute of Technology seek leave to amend the Complete Specification of the Application for **LETTERS PATENT NO. 742666** for an invention entitled "METHOD AND APPARATUS FOR PRODUCING DUPLICATE RECORDS FROM A MASTER MAGNETIC RECORDING."

Particulars of the proposed amendments were set forth in the Official Journal (Patents), No. 3504, dated 11th April, 1956.

Any person may give Notice of Opposition to the amendment by leaving Patents Form No. 36 at the PATENT OFFICE, 25, SOUTHAMPTON BUILDINGS, LONDON, W.C.2. on or before 11th May, 1956. L 105

THE PROPRIETORS OF BRITISH PATENT NO. 665574 for "IMPROVEMENTS IN AND RELATING TO SEWING MACHINE WORK SUPPORTS," desire to enter into negotiations with a firm or firms for the sale of the Patent or for the grant of licences thereunder. Further particulars may be obtained from MARKS & CLERK, 57 and 58, LINCOLN'S INN FIELDS, LONDON, W.C.2. L 221

THE PROPRIETOR OF BRITISH PATENT NO. 645128 for "AN ELECTRICAL GENERATING SYSTEM," desires to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder. Further particulars may be obtained from MARKS & CLERK, 57 and 58, LINCOLN'S INN FIELDS, LONDON, W.C.2. L 103

THE PROPRIETORS OF BRITISH PATENTS NOS. 620609 for "IMPROVEMENTS IN OR RELATING TO AUTOMATIC ARC WELDING DEVICES," 657396 for "ARRANGEMENT FOR SEALING THE MOVING PARTS OF FILLED OR GAS-COOLED MACHINES BY MEANS OF A LIQUID SEAL," 660944 for "IMPROVEMENTS IN OR RELATING TO GAS BLAST ELECTRIC CIRCUIT BREAKERS," 663633 for "IMPROVEMENTS IN AND RELATING TO REMOTE CONTROL SWITCH DEVICES," 670,661 for "ARRANGEMENT FOR SWITCHING-IN GAS BLAST CIRCUIT BREAKERS," and 686611 for "ARRANGEMENT FOR CONTROLLING RESISTANCE WELDING MACHINES," desire to enter into negotiations with a firm or firms for the sale of the Patents or for the grant of licences thereunder. Further particulars may be obtained from MARKS & CLERK, 57 and 58, LINCOLN'S INN FIELDS, LONDON, W.C.2. L 222

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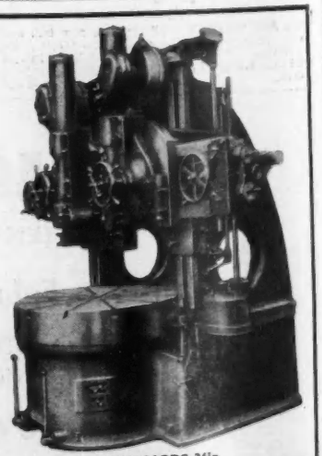

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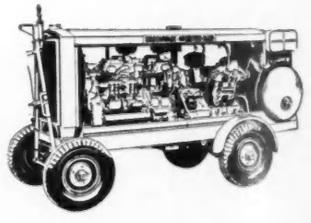

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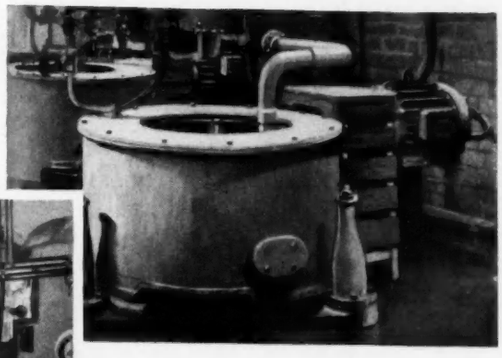

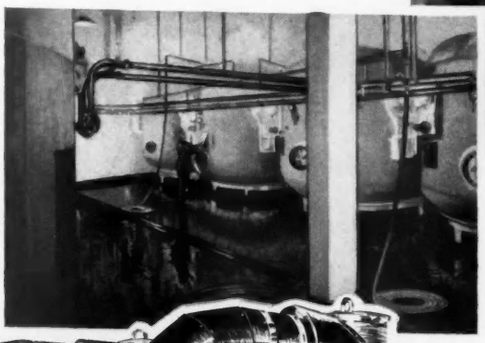

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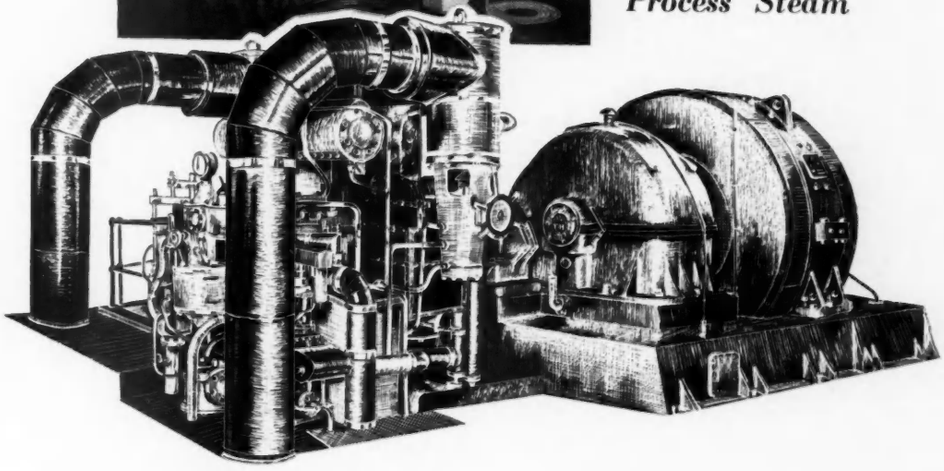

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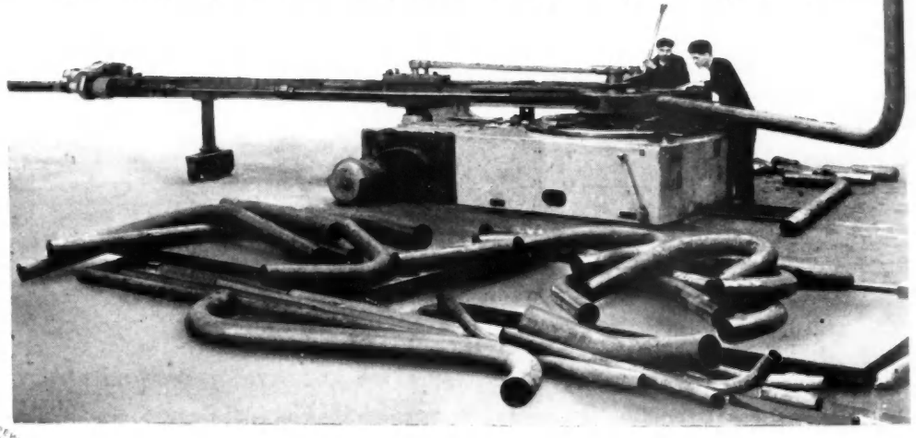

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